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REPORT ON THE APPLICATION OF A HUMAN ERROR ASSESSMENT TOOL TO OFFSHORE CRANE OPERATIONS

INTRODUCTION

This report presents the results of the application of a Human Error Assessment Tool (HEAT) to offshore crane operations. The HEAT was developed under the Joint Industry Project for Human Factors in Offshore Operations (JIP). The purpose of this pilot study was to apply the tool to an offshore activity in order to determine which aspects of the tool are appropriate for offshore operations and which aspects of the tool should be modified to improve ease of use or make the tool more appropriate for the intended user.

Human factors (HF) analysis is directed toward the human-machine interface. The goal of human factors analysis is to identify features of the human-machine interface that can result in system induced human error and to modify these features to reduce the likelihood of that error. The HEAT developed by the JIP is designed to allow the user to identify critical errors and to analyze those errors based on human factors principles. The best corrective measure for the error can then be determined based upon the identified human factors cause.

The focus of the JIP is to identify errors in existing systems that can be corrected by job redesign, procedure redesign, job aids, or training. However, the reader should note that in some cases, the underlying cause of human error is best corrected by a redesign of the human-machine interface itself. Thus, a secondary focus of the HEAT is to gather information to identify areas where modification of design standards or more detailed specification of manufactured equipment is warranted.

SCOPE

This pilot study analyzed general offshore crane operations with a focus on moving loads from service vessels to the platform and vice versa. The study did not focus on any particular crane or crane cab design. Instead, the steps to accomplish movement of a load were identified, followed by identification of possible errors that could occur within those steps.

METHOD

The preliminary Human Error Potential Assessment Tool dated November 1996 was applied to offshore crane operations. (The title of the tool was subsequently modified to eliminate the word "potential.") A copy of this preliminary tool is included as Appendix A to this report. The major elements of the HEAT are described below.

Gross Task Analysis

The Gross Task Analysis is used to define the tasks and steps that must be conducted to accomplish the activity of interest. The results of the Gross Task Analysis represent an outline of the procedure for the activity.

Human Error Identification

Several techniques are used to identify human errors that can occur when performing the procedure steps identified in the Gross Task Analysis. These are:

- Brainstorm possible errors
- Review Accident History
- Conduct Personnel Interviews

Human Error Identification includes a system to rate likelihood and consequences of error in order to identify critical errors for Error Analysis and Corrective Measures.

Error Analysis and Corrective Measures

Error Analysis is only performed on those identified errors that have a high risk index. The Error Analysis involves classifying the errors according to an information processing model. This model assumes that errors can occur at one or more of the following points in the information processing chain:

- Information Source
- Information Channel (Information/Human Interface)
- Information Processor (Operator)

- Output Channel (Human/Control Interface)
- Action (Manipulation of Control)

Identifying corrective measures involves determining the likely causes of error and then making cause-specific recommendations to reduce the potential for error. The corrective measures could involve job redesign (reducing workload; specifying additional operator skills; etc.), procedure redesign (add, remove, or resequence steps), job aids (memory joggers; enhanced labeling; etc.), training, or equipment redesign.

DISCUSSION OF HEAT APPLICATION

General

The Human Error Assessment Tool as described in Appendix A was applied to offshore crane operations. The forms prepared during the pilot study are included as Appendix B.

The gross task analysis, including possible error identification and assignment of likelihood and severity values, was accomplished during approximately 12 hours of meeting between the JIP resources and the subject matter experts.

During the first 4 hours of meeting, two subject matter experts were available. The following 8 hours of meeting were accomplished by using a single subject matter expert. A review of the available accident history was also conducted during this meeting. These previous accidents were categorized by the analysis team according to their judgment as to the human error that occurred.

A drawback to the Human Error Assessment Tool is the degree of documentation that it requires. The current version of the tool requires that task, step, possible error, and severity and likelihood ratings information be documented on forms. This may not be very practical in a group meeting environment, the drawback being that meeting participants cannot see the information after it is generated.

During this pilot study, flip charts were used to collect the information during team meetings. The information was subsequently transferred to forms. This has the advantage that the information can be clarified as it is transferred but the disadvantage

that the information is essentially documented twice. Some options for reducing the work required for documentation are:

- On-line documentation that can be easily edited
- Use of white boards equipped with scanners to provide hard copy
- Where detailed procedures are available, forms can be prepared prior to group meetings

Gross Task Analysis

Detailed procedures for offshore crane operations were not available. As a result, the procedure outline was developed using the available subject matter experts. The team used a white board to outline the tasks associated with offshore crane activities. These tasks were then broken down into the steps required to accomplish each task and were documented using flip charts.

The need to develop procedural outlines for activities to be studied is probably typical. Even where detailed written procedures are available prior to the start of the study, displaying the procedure outline for team review and comment can be used to bound the scope of the HF assessment.

Suggestions for Future Pilots

As a result of Pilot Study #1, the Gross Task Analysis procedures have been modified as follows:

- Additional guidance on conducting the Gross Task Analysis in a meeting environment was added.

Human Error Identification

Brainstorm Possible Errors

Once the tasks and steps for offshore crane operations were identified, brainstorming possible human errors proved to be relatively simple. After the possible errors for each step were identified, the team judged the likelihood of error and the error consequences based on the rating scheme in the HEAT.

Likelihood and Consequence Rating

Rating the likelihood of identified errors using the scheme in the HEAT also proved to be straightforward. However, rating the consequence of error occurrence is not quite as easy. A team can rate the direct and immediate outcome of an error, the worst-case outcome of an error, the most likely outcome of an error, or a weighted (expected) outcome. During this pilot study, the team was directed to rate the most likely outcome of the error. However, a review of the ratings for various errors indicates that the consequence ratings are inconsistent and do not always accurately reflect the effect of latent errors (i.e., those whose consequences are delayed until a later task).

In the HEAT, the base risk index is subsequently modified based on accident and incident history and the modified risk index is used to identify critical errors. As a result, it is important that the HEAT provide some means to track latent errors to ensure they are not overlooked in the final analysis. Although the current rating system is appropriate if used properly, the JIP should evaluate alternatives to determine if a simpler rating system can be used to identify critical errors.

Review of Accident History

The evaluation team was provided a summary of offshore crane related accidents from 1994 - February 15, 1997. This summary included information on the type of loss (property, injury), approximate cost of the accident (if known), the phase of crane operation (lifting, securing, lowering, etc.), and a short description of the accident. The review of the accident summary was performed in approximately 1/2 hour.

This information was sufficient to determine which of the previously identified errors was applicable to the accident. Based on this information, the base risk indices were modified and critical errors identified. No previously unidentified errors were noted during the accident summary review.

Critical Incident Interviews

The current version of the HEAT contains a form to document critical incident interviews. During this pilot study, these interviews were conducted at an offshore platform during work breaks with platform personnel. The interviewers did not document the interviews in the formal manner implied by the forms but instead

conducted informal interviews to verify that earlier steps in Human Error Identification had properly identified the critical errors associated with crane operations.

These interviews did not result in identification of additional likely errors that had not been considered by the analysis team. Interviewees did offer some suggestions for possible solutions to identified errors.

Suggestions for Future Pilots

As a result of Pilot Study #1, the Human Error Identification procedures have been modified as follows:

- The procedure was modified to require the use of brainstorming plus **either** Accident History Review **or** personnel interviews to confirm that the brainstorming was thorough in identifying possible errors. This change was made in recognition that offshore personnel will obtain diminishing returns from the additional human error identification techniques. As a result, the procedure now gives the analysis team the option to choose the most appropriate combination of techniques for each specific study.

- Develop alternative means to identify critical errors (rating system), including some means to track latent errors, and do a side-by-side comparison with the current rating system to identify the method that is the easiest to apply.

Error Analysis and Corrective Measures

Error Classification and Causation

The HEAT proposed an error classification scheme according to an information processing model. The purpose of the classification is to better understand the underlying causes of error so that the most appropriate corrective measures can be determined. The guidance provided to perform this classification was limited and as a result, this step in the process was a bit confusing. The JIP resources concluded that additional guidance is required before a team leader with minimal training could properly classify errors.

Corrective Measures

Once the errors were properly classified and the possible causes for the errors were identified, determination of corrective measures was straightforward. The key is to identify possible corrective measures that modify the system in such a way as to eliminate the specific system-induced cause of human error. For example, errors that result from poor visibility during night time crane operations can be improved by installing and/or maintaining boom mounted lighting systems.

Suggestions for Future Pilots

- Streamline the information processing model to facilitate understanding by less experienced analysis teams.
- Provide improved guidelines for classifying errors into the various human factors cause categories.
- Provide improved guidelines for relating human factors cause categories to possible corrective measures.
- Reduce the number of forms required to analyze errors and identify possible corrective measures from 2 to 1.

MODIFIED HUMAN ERROR ASSESSMENT TOOL

Where appropriate, the HEAT has been modified based on the information obtained during pilot study #1. The modified procedures, forms, etc. are included in Appendix C to this report.

The specific modifications are:

- The procedures for Gross Task Analysis have been expanded.
- The Error Analysis, Accident Analysis, Critical Incident Interviews, and Error Rating have been combined under the category Human Error Identification. The focus on HF Analysis has been deferred until the final step in the process.
- The information processing model has been streamlined and additional guidance has been developed. The guidance has been embedded into the Error Analysis and Corrective Measures form to facilitate application by the analysis team.

- Additional guidance relating the type of error to appropriate corrective measure categories has been developed.

RESULTS OF OFFSHORE CRANE OPERATION ASSESSMENT

The results of the offshore crane operation assessment are represented on the forms contained in Appendix B.

The Gross Task Analysis, including possible error identification and assignment of likelihood and severity values, was accomplished during approximately 12 hours of meeting between the JIP resources and the subject matter experts.

During the first 4 hours of meeting, two subject matter experts were available. The following 8 hours of meeting were accomplished by using a single subject matter expert. A review of the available accident history was also conducted during this meeting. These previous accidents were categorized by the analysis team according to their judgment as to the human error that occurred (Forms 1 and 2).

The analysis team visited an offshore platform following the Gross Task Analysis and Accident Summary review. During this visit, we observed a load being moved from the top deck to a lower deck. Part of this movement was a blind lift, requiring the use of a signalman between the crane operator and riggers.

The operation was typical for a platform with an active drilling rig. The crane crew consisted of a crane operator plus 2-3 riggers. This team had worked together for several years. This personnel arrangement is not common for a typical production platform, where crane operator and rigger experience and rigger availability vary widely.

While on the platform, the analysis team interviewed the contract crane operator as well as 3 production personnel that routinely operate cranes during the course of their normal duties. The information obtained during these interviews was not documented formally. It did, however, reinforce the information that had been developed during earlier phases of the study.

Critical errors (those with high risk indices) were then classified according to which stage in the information processing chain could induce or exacerbate the error (Form 4). Possible causes of each error and the likelihood of each cause were assessed and possible corrective measures identified (Form 5). Corrected actions may include

procedure redesign, job redesign, job aids, training, or redesign of the human-machine interface. A summary of the critical error analysis begins on Page 10.

Interestingly, an internal study of offshore crane safety had recently been completed. This earlier study was done by a team of four company personnel meeting for approximately 2 days.

In comparing the results of the earlier study with those of the human error assessment, we noted that most of the errors were identified in both studies. However, the human error assessment tool requires a more thorough analysis of the cause of error and, as a result, may suggest corrective measures that are ultimately more workable.

For example, both studies indicated that failure to conduct pre-lift crane inspections is a critical error. Without benefit of the human error assessment, the corrective measure for this error might be "enforce the performance of a pre-lift crane inspection prior to each lift." This corrective measure may be appropriate and sustainable as long as a system for enforcement is established and maintained.

However, one reason for failure to conduct a pre-lift crane inspection is the urgency, real or perceived, created when a service vessel arrives without warning (failure to receive communication) or during a time where competing demands (high workload) tempt the operator to take short cuts.

If these situations occur frequently, it may be more appropriate to establish a back-up communication system (from boat to a continuously-staffed shore station with the shore station notifying the platform via telephone that sounds a horn on platform) or enforcement of a daily crane pre-check and operational check to be conducted during slack workload, regardless of whether crane use is expected.

Although these solutions may be less desirable from an absolute perspective, they may prove to be more workable and sustainable because they address the problems that actually confront the platform operator on a daily basis.

Summary of Critical Errors and Possible Corrective Measures
Offshore Crane Operations

Task	Step	Error	Causation Stage	Cause	Possible Corrective Measure
Prepare Equipment and Crew	Conduct pre-lift crane inspection	Failure to conduct pre-lift crane inspection	IP	Excessive workload, time constraints	Establish and/or enforce procedure to conduct daily crane checks during slack periods.
			IP	Possible consequences not understood.	Improve training and supervision. Establish mandatory checkpoints in procedure to "tickle" compliance.
			IC	Advanced notification of boat arrival not received	Provide backup ship-to-platform notification to ensure advanced warning is received.
Attach Load	Riggers move clear after attaching load	Riggers do not move clear of load	IP	Use of untrained riggers.	Ensure availability of trained riggers through manpower planning or contract specification.
Lift Load	Raising the hood (take up slack)	Winch up with sling wrapped around obstacles	IC	Crowded boat deck	Develop and implement specifications for cargo spacing on boat decks.
			IC	Poor deck illumination	Install and/or maintain boom lighting systems.
			IP	Use of untrained riggers.	Ensure availability of trained riggers through manpower planning or contract specification.
		Apply line tension before boom is centered over load.	OC	Operator selects wrong control lever	Modify crane controls to enhance control differentiation.
			OA	Operator cannot track vessel movement	Develop and implement criteria for conducting lifts to and from service vessels in high seas and adverse weather.
	Raising the hood (take up slack)	Winch up the wrong line	OC	Operator selects wrong control lever	Modify crane controls to enhance control differentiation.

Causation Stage Legend: IS = Information Source, IC = Information Channel, IP = Information Processor, OC = Output Channel, OA = Output Action

Notes: (1) No corrective measure suggested due to low likelihood associated with this cause.

Summary of Critical Errors and Possible Corrective Measures
Offshore Crane Operations

Task	Step	Error	Causation Stage	Cause	Possible Corrective Measure
Lift Load	Winch load off the deck	Winch up an improperly rigged load	IS	Improper sling used	(1)
			IS	Sling not properly attached	Ensure availability of trained riggers through manpower planning or contract specification.
			IS	Use damaged sling	(1)
			IS	Sling not load tested	Establish and implement and/or enforce practice to load test all new slings at onshore facilities before they are delivered offshore.
			IS	Incorrect sling angle	(1)
	Swing load clear of boat deck	Swing boom before load clears obstacles.	IP	Lifting loads from vessel in rough seas.	Develop and implement criteria for conducting lifts to and from service vessels in high seas and adverse weather.
			OA	Boat shifting during slow lift using load line	(1)
	Raise load above platform obstacles	Winch up too high	IS	Crane being operated with out of service anti two-block device.	Establish and/or enforce prohibition against using cranes with out of service anti two-block devices.
		Boom up too high	IS	Crane being operated with out of service boom kick-out device.	Establish and/or enforce prohibition against using cranes with out of service boom kick-out devices.
Lower and un-hook the load	Winch down the load	Winch down too fast	IP	Workload, time pressures	(1)
			OA	Operator applies excessive control action	(1)

Causation Stage Legend: IS = Information Source, IC = Information Channel, IP = Information Processor, OC = Output Channel, OA = Output Action

Notes: (1) No corrective measure suggested due to low likelihood associated with this cause.

Summary of Critical Errors and Possible Corrective Measures
Offshore Crane Operations

Task	Step	Error	Causation Stage	Cause	Possible Corrective Measure
Lower and un-hook the load	Rigger detaches slings	Rigger fails to properly secure slings ropes after detaching	IP	Rigger not aware that sling ropes may swing freely	Ensure availability of trained riggers through manpower planning or contract specification.

Causation Stage Legend: IS = Information Source, IC = Information Channel, IP = Information Processor, OC = Output Channel, OA = Output Action

Notes: (1) No corrective measure suggested due to low likelihood associated with this cause.

APPENDIX A
PRELIMINARY HUMAN ERROR POTENTIAL ASSESSMENT TOOL
Dated November 1996

Joint Industry Project on
Human Factors in Offshore Operations

HUMAN ERROR POTENTIAL ASSESSMENT TOOL

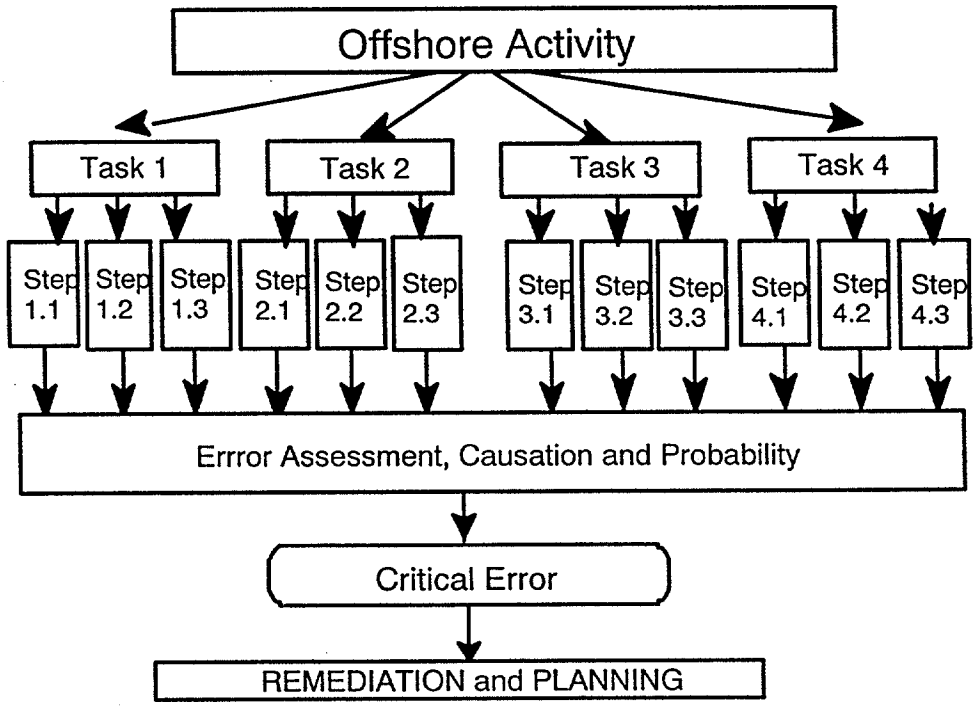
Draft Version A

EQE Project Number 59122

November 1996

Purpose Identify critical errors, and remedial measures. Improve contingency plans.	The Human Error Potential Assessment, or HEPA, is a tool designed to allow teams of trained users to examine the activities of a particular **system** in order to identify those potential human errors that could lead to significant failure of the system. The purpose of the HEPA is to identify **critical errors**, to recommend measures to reduce the likelihood of their occurrence, and to foster plans for dealing with the consequences of the errors should they occur. Since the tool requires a thorough examination of system activities by a trained assessment team, the process itself may lead to many other suggestions for improvement.
Scope	Although the HEPA tool can be applied to any system, it was developed to evaluate the potential for human error during offshore and remote onshore oil and gas drilling and production activities.
Limitations Will not eliminate all errors. Subjective.	The HEPA tool cannot identify every possible error nor can it solve all problems related to humans in systems operations. It is a subjective and qualitative process. Its strength lies in the diligence and insight of those involved in its application. It should never be rigidly applied and should be modified as necessary. If the process is undertaken conscientiously and remedial measures are applied, it can reduce the risk associated with the activities examined.
General Approach Define, Identify, Remediate, Plan.	In general, the approach involves defining an activity in its most elementary steps so that potential errors associated with each step can be identified. The errors identified must be rated in terms of the likelihood of their occurrence and the severity of the consequences. Errors that have high rating, or critical errors, must be further analyzed for their potential causative factors so that remedial measures can be recommended. Contingency plans must also be examined to assess how the occurrence of critical errors will be managed.
Gross Task Analysis	The application of the HEPA tool involves following the steps necessary to answer the following questions: 1. What is the activity of interest? 2. What are the major tasks performed in the activity? 3. What are the steps performed in each major task?

Error & Accident Analysis, Critical Incident Interviews.	4. What are the potential errors for each step? 5. How likely is each error? 6. What is the consequence of each error? 7. Which are the most critical errors? 8. What is the cause(s) of these errors?
Remediation & Contingency Analysis.	9. How can these errors be reduced or remediated? 10. Are the plans for dealing with critical error occurrence adequate?
	An overview of the General Approach of the HEPA is presented in the diagram given below:



Phase 1	Gross Task Analysis
Gross Task Analysis (GTA)	The first step in reducing critical human errors is to analyze the operations in which they can occur. This involves performing a Gross Task Analysis. It is considered gross in the sense that is not to be performed for the purpose or at the level of detail that such analyses generally are performed.
Objectives	This analysis is a process of defining the boundaries of the activity of interest, then reducing the activity to its most elemental steps. The objectives of this analysis are to define the activity of interest, define the tasks required to perform the activity and to identify the steps necessary to perform each task. It must be stated that this is an arbitrary and subjective process. Boundaries can be drawn in many ways and steps can be defined at various levels. However, the ultimate goal is identifying potential errors associated with each step, so it is important that the boundaries be narrow and that the steps be as elementary as possible.
Requirements	• An evaluation team of three or more people, at least one of whom is knowledgeable about the activity being analyzed. • Job or task descriptive information. • Copies of Forms 1 and 2.
Procedures	The following procedure outlines the analytic process. Guidelines and examples are presented for clarity. GTA 1: Define Activity An activity is a distinct subset of the overall operation. It is goal directed and has action oriented tasks and steps within each task. Examples of activities: Surface vessel supply Crane operations Well-kick control Record and describe the activity of interest on Form 1.

Procedures (Cont.)	GTA 2: Define Tasks A task is defined as a **function** performed by either a human or a machine in the accomplishment of an activity. Examples of tasks in crane operation: ■ Position crane to predetermined location ■ Attach load ■ Lift load ■ Move load ■ Position load to predetermined location ■ Release load ■ Secure crane Record and describe tasks on Form 1. Transfer each task to a single Form 2. GTA 3: Define Steps Steps are the actions involved in completing a task. A step is a subgoal required to achieve task completion. Examples of steps in positioning crane to predetermined location: a. Select location to move crane b. Visually acquire location c. Operate crane controls to move/position/lower crane d. Stop crane Record and describe the steps associated with a given task on its corresponding Form 2.

Phase 2	Error Analysis
Error Analysis (EA) Objective	The ultimate objective of the Error Analysis is to identify those critical human errors that might occur during the activity of interest. This process involves analyzing the steps, reviewing accident data and interviewing knowledgeable personnel.
Requirements	• The evaluation team. • Five personnel experienced in the activity that will be interviewed in the critical incident process (see CI). • Any available accident data for this activity or its onshore equivalent. • All Form 2s from the GTA.

Procedures	EA 1: Identify Potential Human Errors The critical human errors are derived by first examining the steps associated with each task and then identifying potential human errors for each step. Equipment or material failures are not part of the scope. Descriptive terms used for these potential errors are generally negative in content (i.e., state that the step is performed incorrectly or omitted). An example of a human error in positioning the crane: Choosing incorrect location to which to move the crane Incorrectly operate crane controls Record and describe the potential errors on Form 2. EA 2: Rate Likelihood of Errors The second step in the EA is to assess the likelihood of occurrence for each potential error. This is done using the five point rating scale given below: Likelihood of Error 1 Low 2 3 Medium 4 5 High For example, incorrectly operating crane controls may receive a "2" rating for likelihood of occurrence. Record the average ratings of team members in column 3 on Form 2.

Procedures (Cont.)	EA 3: Rate Consequences of Errors Each error must be rated in terms of its consequences. Again this is a subjective estimate by each team member, with the average being recorded on the form. The rating scale is presented below: Consequence of Error 1 Delays — 2 Equipment Damage — 3 Injuries and Major Equip. Damage — 4 Death, Severe Inj., Equip. Loss — 5 Loss of System and Lives Example: Incorrectly operating crane controls. Due to the severity of the error consequences this error could rate a high severity value of "4." Record average ratings of team members in column 4 on Form 2. EA 4. Estimate Risk Risk is defined as the likelihood of unwanted consequences. In this case, risk is estimated by the product of the subjective ratings. Example: Incorrectly operating crane controls. Since the likelihood of error was a "2" and the consequence of the error was a "4," multiplying the two ratings together gives an "8" for that human error. Multiply the ratings in columns 3 & 4 and enter in column 5 on Form 2. Remember the values in columns 3 and 4 are the *average* of the raters' scores.

Phase 3	Accident Analysis
Accident Analysis (AA) Objective	Accident data are analyzed to supplement and reinforce the EA. All accident data available from both on and offshore systems related to the particular activity are reviewed. Errors related to task steps are identified and enumerated.
Requirements	• The evaluation team. • Written accident reports available for the activity. • Completed Form 2s from previous analyses.
Procedures	AA 1: No Accident Records If no accident data exist for a given step, the analysis is complete for that step. Continue the review until accident data is found for a given step. AA 2: Accident Data Present If accident data exists for a given step, examine it carefully to determine if there is an error present that has been previously listed for that step. If the error has been previously enumerated, revise the values in columns 3 and 4, as necessary, then proceed to the adjustment of the risk estimate (AA 4). If the error has not been enumerated, add it to the list under the step (or on a supplemental page). AA 3: Rating Likelihood and Consequences Since the accidents have occurred, they have a high likelihood and some level of consequence. Therefore entries in columns 3 and 4 should reflect the appropriate values. Estimate these values and enter them on the appropriate line in columns 3 and 4 on Form 2. Place the product of these two values in column 5.

Procedures (Cont.)	AA 4: Adjustment of Risk Estimate The risk estimate in column 5 will be modified by known accident experience. The modifier will be one of three values: 1 for no accident experience 2 for few accidents 3 for frequent accidents Place one of these values in column 6 on Form 2. Example: During past accident record review, the team noted a few accidents involving the crane activity. Improper or incorrect operation of the crane controls was determined to be the cause of the accident. Therefore, a "2" is assigned in column 6 to correspond to the few accidents attributed to that occurrence.

Phase 4	Critical Incident Interviews
Critical Incident Interviews (CI)	The critical incident (CI) technique is a method of accident research in which people who have experience with the activity of interest are interviewed and asked to provide detailed descriptions of unsafe acts, near-misses or actual accidents they have observed. The basic assumption of the technique is that, given enough information regarding a large number of these incidents, one can determine the errors associated with an activity that lead or might lead to an accident or near-accident.
Objectives	There are three objectives for the CI interviews; first, to refine or supplement the error and accident analyses; second, to gather information about the level of knowledge of the interviewees concerning the responses they should or would make in the event that the errors noted would have resulted in accidents; and, third, to observe the performance or simulated performance of the operation of interest.
Requirements	• The evaluation team. • At least five personnel that currently perform or supervise the activity of interest. • Completed Form 2s from the previous analyses. • Observation of the operation, if possible.

Procedures	Data can be obtained through several methods, including personal interviews, group interviews, questionnaires, checklists, and observation. The personal interview is the preferred method of obtaining data, although it is time consuming. CI 1: Conduct Interviews Interview each person individually. Make the interviews as informal as possible. Let those being interviewed know that no names will be included in the report and that all responses are strictly confidential. One of the evaluation team members can lead by asking the questions outlined in Form 3, the others will record responses and ask follow-up questions. Examples: The following types of questions can be asked to obtain data: "Think of a situation in which an accident occurred or almost occurred while performing a given task. What were the general circumstances leading up to this accident? Exactly what did the operator do which contributed to the incident? When did this incident occur? What was the operator's job? How long has the operator been performing this job? What would you do if this type

Procedures (Cont.)	of accident occurred?" The questions and responses must be of sufficient detail to provide information which will allow the investigators to make inferences and predictions about the associated behaviors. Record the responses on Form 3. CI 2: Revise Error Data For each incident described in the interviews, determine if there is an error present that has been listed for a step on Form 2. If the error has been previously enumerated, revise the values in columns 3 and 4, as necessary, then proceed to the adjustment of the risk estimate (AA4). If the error has not been enumerated, add it to the list under the step (or on a supplemental page). CI 3: Rating Likelihood and Consequences Since the near-misses, incidents or accidents have occurred, they have a high likelihood and some level of consequence. Therefore entries in columns 3 and 4 should reflect the appropriate values. Estimate these values and enter them on the appropriate line in columns 3 and 4 on Form 2. Place the product of these two values in column 5. CI 4: Adjustment of Risk Estimate The risk estimate in column 5 will be modified by known incident experience. The modifier will be one of three values: 1 for no incident experience 2 for few incidents 3 for frequent incidents Place the appropriate value in column 7 on Form 2. CI 5: Observe Operations (if possible) Look for potential error sources. Listen to proposed remedies for the errors. Example: With a knowledgeable working person, observe the operation of the crane controls and watch for inadvertent activation of another control. Perhaps the worker will suggest a guard over the troublesome control.

Phase 5	Determine Critical Errors
Determine Critical Errors (CE)	While all potential human errors are of interest and need to be addressed in some fashion, those that can cause significant loss should be addressed first. These potential errors are defined as critical. An error may be deemed critical if the estimate of the risk associated with them is above a specified level. The level specified may be arbitrarily determined, or the list of potential errors may simply be ranked in order with a cut-off imposed at natural break points in the list. However it is done, the selection of critical errors is necessary so that a manageable number of errors remain for further analysis.
Requirements	• The evaluation team. • All the previous completed Forms • Form 4.
Procedures	CE 1: Determine Modified Risk Value Multiply the estimate of risk in column 5 by the larger of the accident modifier in columns 6 or incident modifier in column 7. Example: The accident modifier value is a "1", while the incident modifier is determined to be a "2". Therefore, the value of "8" obtained by multiplying columns 3 and 4 values, is now 8*2 or "16", for the new modified risk value. Record the Modified Risk Value in Column 8. CE 2: Determine Critical Errors Select all potential errors that have a value above 12. Example: Given the value of "16" above, it must be determined to be a critical error. Record the task, step, error and risk information on Form 4.

Phase 6	Error Causation
Error Causation (EC)	This stage of the HEPA is directed at finding the causes of the potential human errors that were rated as critical. This is an analytic process that categorizes and classifies the selected errors by the factors that may induce or exacerbate them. Once these factors are known, remedial measures can be developed to reduce the likelihood of their concurrence. It must be understood that humans make many errors, many of which are not system related. Fortunately, most errors are harmless, self correcting or are tolerated well by the machine being operated. The non-system related, or idiosyncratic errors, are very difficult to remediate and are not the focus of this assessment. System related, or systemic errors, on the other hand, can be controlled. The approach taken to determine error causation is an information processing approach. This approach assumes that errors result from some failure in the information processing chain. This chain is depicted in the diagram below. 
Information Sources	Information sources include anything or any person in the operator's environment that has the potential to provide indications of the system's status. This includes parts of the machinery such as gauges, lights, and auditory signals; by-products of the machinery's operation such as changes in temperature, noises, and odors; and people such as signalers, other operators, etc.
Input Channels	Any environmental source of information must ultimately impact one or more of the operator's sensory modalities in order to be perceived. The most commonly used in control tasks are visual and auditory sensations, although other modalities such as touch and smell are often of critical importance in determining what actions are appropriate in a given situation.

Information Processor	The human central nervous system acts an information processor. It takes all the sensory data from the input channels to the central nervous system, generates thoughts, and selects or programs actions. Some information processing is simple or "reflexive" in nature, as when we touch a hot stove and immediately jerk our hand away. Even in such simple cases, the central nervous system has processed a sensory input (from a pain receptor in the skin) and sent the command for action (to motor neurons in the arm and hand). More complex actions, such as those requiring conscious decision-making on the part of the operator, involve the brain and mental functions such as memory (of learned rules or previous experience), comparisons (between current and expected conditions), attention (determining which inputs are important and which to ignore), and response generation (planning and sequencing actions).
Output Channel	Once an action plan is generated mentally, the appropriate signals must be sent in order to carry it out. The human body has several output channels making actions possible. All share the common features of motor neurons under central nervous system control transmitting signals to the skeletal muscles that make movement and speech possible.
Action	Actions are the controlled movements of the body's limbs or vocal apparatus to affect a change in the environment or the body's position relative to the environment. They can be purposeful or reflexive in nature, but all share the common features of central nervous system control and coordinated, sequenced movement of the body.

Failures in the Information Processing Chain	The failures that occur can be attributed to humans, acting as information sources, processors or receivers (signal person, machine operators, etc.) or actors; machines that serve as information sources, action elements or transmission channels (controls, displays, radios, etc.), or to the environment in which the communication takes place (noise, dark, adverse weather, etc.) Failures in the information processing chain can be caused by: Failure of the source where the needed information is: ▪ not present ▪ not present at the right time ▪ not detectable ▪ incorrect Failures in the input channel that cause the information to be: ▪ disrupted ▪ distorted ▪ delayed Failures in processing such that the information is: ▪ misinterpreted ▪ ignored
Failures in the Information Processing Chain (Cont.)	Failure in the output channel such that the action is: ▪ delayed ▪ improperly controlled Failure in the output such that the action is: ▪ incorrectly performed Each critical potential human error must be classified according to one or more of the sources of information processing failures. Once these are known, remedial measures can be identified.

Phase 7	Error Cause Assessment
Error Cause Assessment	In most interactions between humans and the systems they operate, the potential causes of errors are related in complex and often not immediately apparent ways. It is important to realize that there will be alternative explanations and multiple possible causes for any potential error. Without addressing all the likely causes of error, remedial measures taken will not be enough to eliminate the risk, and, in some cases, may even raise the risk of an error. In classifying human errors, therefore, it is crucial to consider all possible reasons for the error by judging the likelihood of any causal explanation. Form 5 is to be used in conducting an error cause assessment.
Objective	The objective of Error Causation is to identify and classify the important potential causes of each critical error so that remedial steps can be developed to address each error. Remember that the Causal assessment is to be carried out only for those errors rated as "critical" in the Error Analysis. These are the errors that, through a combination of their likelihood and their consequences, are the most important to address. Consulting the list of critical errors, the following procedure will be used to identify the potential causes for those errors.
Requirements	The evaluation team All the previously completed forms Form 5

Procedures	The following procedure outlines the analytic process. Guidelines and examples are presented for clarity. EC 1: Select Critical Errors for Analysis A critical error is one identified as high risk as a result of the preceding analyses (GTA, EA, AA, and CI). These are the errors that, by virtue of their likelihood and/or consequences, pose the greatest threat to safe and continued operation. Examples of critical errors: Failure to operate crane controls correctly Failure to see warning light for pressure level Record the critical error of interest on Form 5. Use one copy of form 5 for each critical error identified in Forms 1-4.

Procedures (Cont.)	EC 2: Describe Possible Causes of Error The possible causes of error are based on the information processing approach. Errors can result from one or more failure(s) at one or more link(s) in the information processing chain: • Information Source • Input Channel • Information Processor • Output Channel • Output (Action) At each link in the information processing chain, use Form 5 to list the possible error causes of that type. Examples of Potential Error Causes: Information Source: - Warning Light Burned Out - Background Noise, Siren Inaudible Input Channel: - Operator Deaf - Operator Color Blind Information Processor: - Operator Misreads Gauge - Operator Confuses Similar Correction Procedure Output Channel: - Operator Applies Excessive Pressure to Controls Output (Action): - Operator Activates Controls Out of Intended Sequence - Operator Turns Control Handle in Opposite Direction of that Record the list of potential Error Causes on Form 5 for each link in the Information Processing Chain.

Procedures (Cont.)	EC 3: Assess the Likelihood Not all possible causes of error are equally likely to occur. Since the cost of remedial measures can be quite high, it is important to identify those causes of error which are most likely to occur. Using Form 5, rate the likelihood of each cause of an error. Likelihood of Error Cause 1 2 3 4 5 Low Medium High Examples of Error Likelihood Ratings: Information Source; Background Noise, Siren Inaudible Average Likelihood Rating = 4.2 Record the average likelihood rating of team members on Form 5.

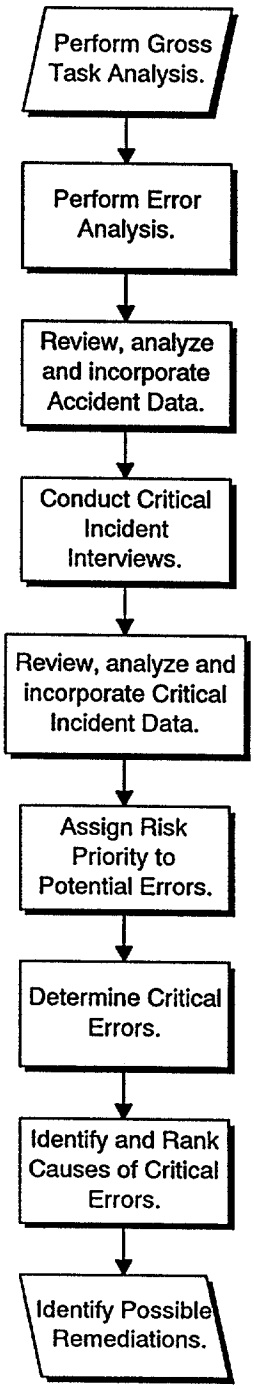
Remediation (R)	Remediation involves procedural changes, training, retraining and even changes to the individual activity task steps in order to avert or reduce potential for errors. In the case of the INFORMATION SOURCE being the error causation, training can be implemented to ensure that the human knows what information is needed in order to complete the task step and where to look for that information. Also, inappropriate information must be recognized, i.e., the human operator must know which information to pay attention to and which to ignore. If the information is received from a machine, the causes for why that information was not available must be researched and if the capability exists for an information display to be present, with a minimum of investment, the possibility for that display presence should be investigated. INPUT CHANNEL errors are those in which the information is present, but the quality of the signal is disrupted. This can apply to both human and machine. The human error can stem from the information not being received correctly due to some environmental disturbance, like too much noise or inclement weather. The machine providing the information can also be at less than perfect transmission. Researching the causes for why the information was disrupted, distorted or delayed can help identify where to target the assistance for efforts aimed at both human and machine. If an outside factor, not under one's control, like the weather or noise, is the culprit in this phase of information processing, then contingency plans may have to be implemented where assumptions and backup plans are instituted in the case of incomplete or distorted information.

Remediation (Cont.)	Where the INFORMATION PROCESSOR is seen as the cause of the error, the majority of the failures will come from the human psychological or physiological shortcomings. In the category of psychological, things to pay attention to are: Memory loading - are we asking the human operator to remember too much information? Learning problems - is our training sufficient Attention - is the information prominent enough and recognized as the element the human must attend to? Motivation - is our employee motivated to do his/her job? Is the workload too high? Can we off-load some of the processing to the machine? Situation awareness - is the worker aware of the environment in which he/she is working? Is sufficient training provided to allow the worker to know where/when to look for information that is critical to the correct completion of a task? If a physiological problem could be at the root of an error in information processing, the sources would be in the human operator's level of - fatigue - stress - life requirements/obligations - fitness for duty in terms of drugs or alcohol abuse For remediation where physiological factors are to blame, screening may be required to evaluation life requirements and fitness for duty. Where fatigue and stress may be the cause, the remediation would be an evaluation of workload requirements, job responsibility and adequacy of rest breaks and shift schedules. In the case of OUTPUT CHANNEL being the malefactor in the cause of a critical error, the information processed by the operator may have again been disrupted, distorted or delayed before leading to an action. Here, the remedial solution would lie in assuring the correct output is selected through appropriate training in the cause and effect. If the environment plays a contributing role to the distortion or delay, all measures should be investigated which would minimize the impact of the outside factors like noise, vibration and insufficient illumination.

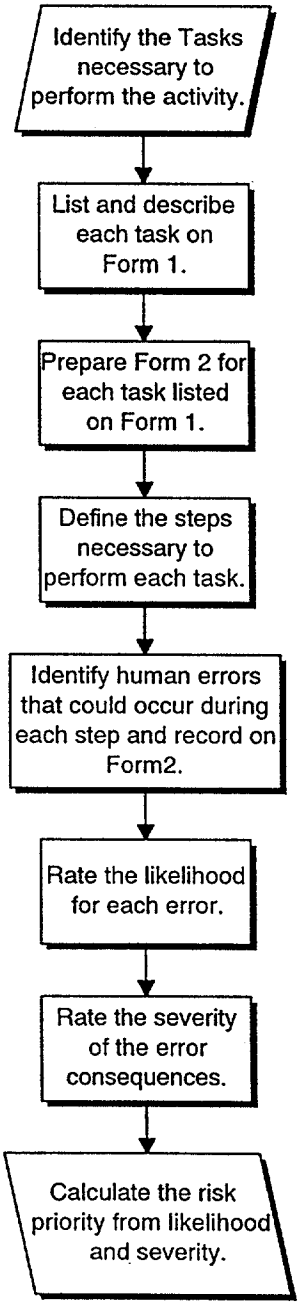
Remediation (Cont.)	The final stage where information processing can go amiss is in the OUTPUT ACTION phase. In this case, the human operator chooses the incorrect action, given the information present. An inaccurate, inappropriate or untimely action can be remedied through training and procedures review.
Contingency Planning (CP)	Contingency or emergency planning is necessary. This would involve reviewing the critical errors possible in the operations, tasks and steps. Where those errors are frequent or will result in severe injury or death or loss of equipment, emergency procedures must be developed, trained and implemented. It is important to review the contingency plans on a periodic basis to update their requirements, as procedures may change or operations may be altered, redesigned or superseded.

FLOW CHARTS

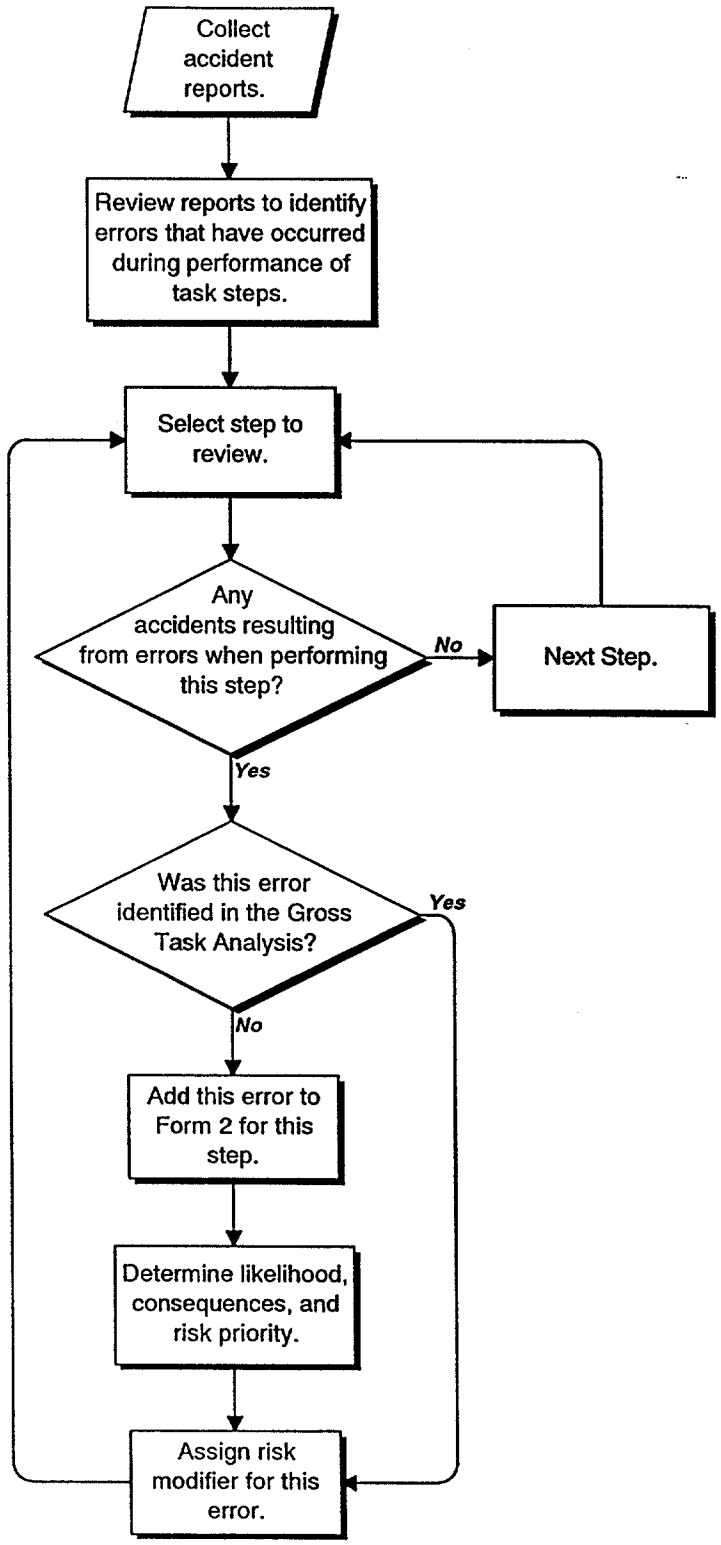
Human Error Potential Assessment
HEPA



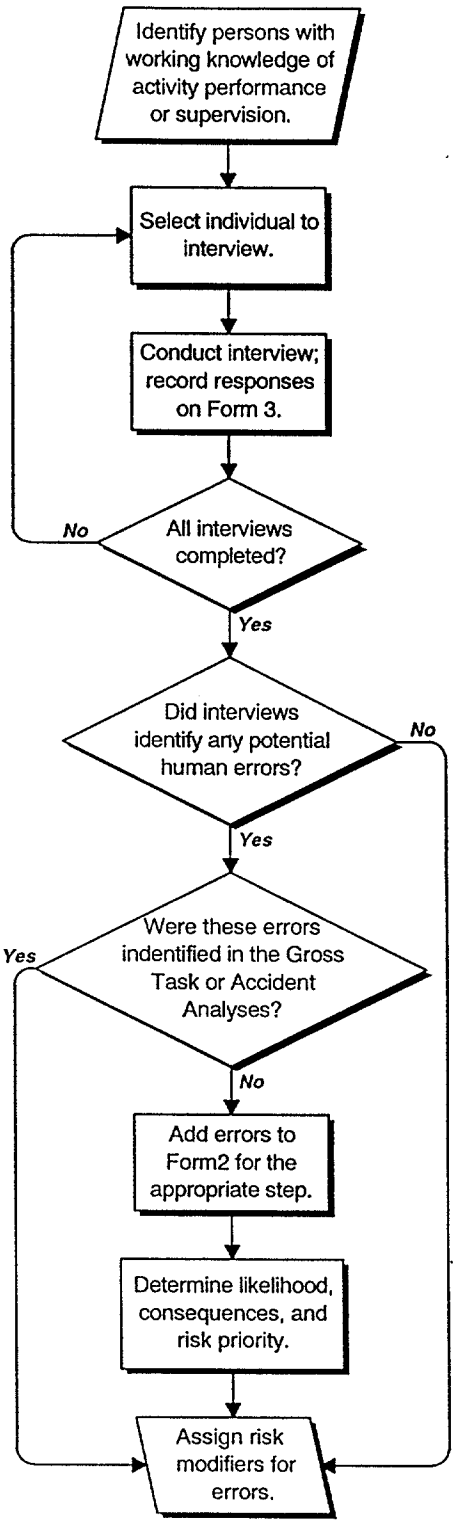
Gross Task Analysis



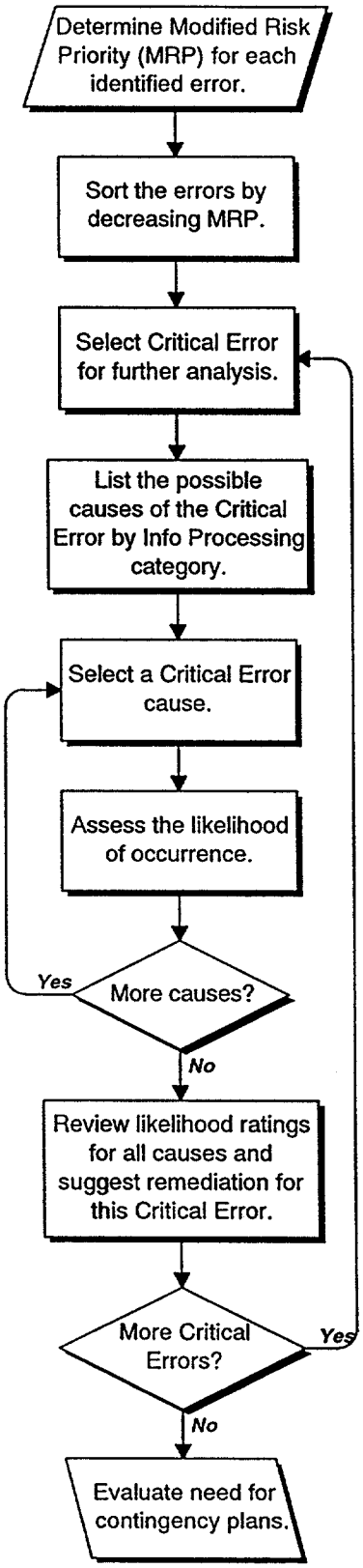
Accident Analysis



Critical Incident Interviews



Identify Critical Errors, Their Causes, and Possible Remediations



FORMS

Form 1 - Description of Activity

Date: _____

GROSS TASK ANALYSIS

Name of Activity	Description of Activity
Crane operations	Human, in conjunction with the crane, moves loads on and off the vessel and the off-shore facility.

Gross Task Analysis - Task Description	
Task Name	**Task Description**
1.0 Position Crane to predetermined location.	Crane operator determines what load needs to be moved and positions the crane the pick up the load and move it.
2.0 Attach load	Crane hook is used to attach the load and secure it.
3.0 Lift load	Crane lifts the load up off the vessel or off-shore facility.
4.0 Move load	Load is moved to the desired final location.
5.0 Position load to predetermined location	Crane operator, with the crane, positions the load to the desired location on the vessel or on the offshore facility.
6.0 Release load	Hook is taken off the load. Load is now in new desired location.
7.0 Secure crane	Crane is turned off, controls locked and other procedures accomplished to secure crane.

Form 1 - Description of Activity

*Date:*_____

GROSS TASK ANALYSIS

Name of Activity	Description of Activity

Gross Task Analysis - Task Description	
Task Name	**Task Description**
1.0	
2.0	
3.0	
4.0	
5.0	
6.0	
7.0	
8.0	
9.0	

Form 2 - Description of Steps in Tasks

Date: _____

Activity: _____

Task Number and Name: 1.0 - Position the crane to a predetermined location

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	**Human Error Description**	**Likeli-hood of Error*** (1-5)	**Conseq-ence of Error**** (1-5)	**Risk Esti-mate** (Col 3*4)	**Accident Risk Adjust *** (AccidentAnal)**	**Incident Risk Adjust**** (Critical Incid)	**Modified Risk Value** (Larger of number in Col 6 or Col 7 * Col 5)
1.1 Select location to move crane	Wrong location selected						
1.2 Visually acquire location	Wrong location selected						
1.3 Operate crane controls to move/position lower crane	Incorrectly operate crane controls	2	4	8	1	2	16 (8 * Col 7 value)
1.4 Stop crane							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: _____

Activity:_____

Task Number and Name:_____

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	**Human Error Description**	**Likeli-hood of Error*** (1-5)	**Conseq-ence of Error**** (1-5)	**Risk Esti-mate** (Col 3*4)	**Accident Risk Adjust *** (Accident Anal)**	**Incident Risk Adjust**** (Critical Incid)	**Modified Risk Value** (Larger of number in Col 6 or Col 7 *Col 5)
n.1							
n.2							
n.3							
n.4							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 3 - Critical Incident Interview

Date: _____

Activity: _____

Task Number and Name: 1.0 - Position the crane to a predetermined location

Critical Incident Questions and Responses	
Can you think of a situation in which an accident occurred or almost occurred while performing this task?	Yes No
What were the general circumstances leading up to this incident?	
How often has this occurred?	
Exactly what did the operator do which contributed to the incident?	
When did this incident occur?	
What was the operator's job?	
How long has the operator been performing this task?	
What needs to be done to prevent this type of incident?	
What would you do if this type of accident occurred?	
Other comments?	

Form 4: CRITICAL ERRORS Analysis **Date:** _____

** Critical Errors are those which have caused significant loss or if the value in Column 8 of Form 3 is "12" or above

Activity:_____

Task: _____

CRITICAL ERRORS ANALYSIS							
Step Number and Name	**Human Error Description**	**Error Causation Stage-Check all that apply**					**Comments**
		Info Source	Input	Info Processor	Output Channel	Output Action	
n.1							
n.2							
n.3							
n.4							

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:

_____

_____

STEP TWO: EC2 — List Potential Error Causes

Source of error: _____

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: _____ _____

1 2 3 4 5
Low Medium High

2: _____ _____

1 2 3 4 5
Low Medium High

3: _____ _____

1 2 3 4 5
Low Medium High

4: _____ _____

1 2 3 4 5
Low Medium High

Potential Remedial Measures
1.
2.
3.
4.

APPENDIX B
HUMAN ERROR ASSESSMENT OF OFFSHORE CRANE OPERATIONS
COMPLETED FORMS

Form 1 - Description of Activity

Date: 3/1/97

GROSS TASK ANALYSIS

Name of Activity	Description of Activity
OFFSHORE CRANE OPERATIONS	1) MOVE LOADS ON PLATFORM (TOP DECK AND BETWEEN DECKS) 2) MOVE LOADS FROM PLATFORM TO SERVICE VESSEL. 3) MOVE LOADS FROM SERVICE VESSEL TO PLATFORM.

Gross Task Analysis - Task Description

Task Name	Task Description
1.0 DETERMINE LIFT REQUIREMENTS	
2.0 ASSIGN CRANE OPERATOR	
3.0 PREPARE EQUIPMENT AND CREW	
4.0 RIG UP CRANE	
5.0 POSITION CRANE OVER LOAD	
6.0 ATTACH LOAD	
7.0 LIFT LOAD	
8.0 POSITION CRANE FOR LOWERING LOAD	
~~9.0~~ 8.0a POSITIONING LOAD WITH A SIGNALMAN	

Form 1 - Description of Activity

Date: 3/1/97

GROSS TASK ANALYSIS

Name of Activity	Description of Activity

Gross Task Analysis - Task Description	
Task Name	**Task Description**
~~9.0~~ 9.0 LOWER AND UNHOOK LOAD	
~~2.0~~ 10.0 RIG DOWN CRANE	
~~3.0~~ 11.0 SECURE CRANE	
4.0	
5.0	
6.0	
7.0	
8.0	
9.0	

Form 2 - Description of Steps in Tasks

Date: 3/1/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 1.0 DETERMINE LIFT REQUIREMENTS

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 RADIO CALL FROM CAPTAIN	DON'T RECEIVE CALL	4	1	4			4
n.2 DETERMINE TIME FRAME FOR LIFT	INCORRECT VESSEL ETA GIVEN	4	1	4			4
n.3 SPECIFY LOAD PARTICULARS.	INCORRECT LOAD WEIGHT SPECIFIED	4	2	8			8
	INCORRECT PACKAGING TYPE SPECIFIED	1	1	1			1
	INCORRECT LOAD SEQUENCE SPECIFIED	1	1	1			1
n.4 DETERMINE NEED FOR RIGGERS ON BOAT	RIGGER NEEDS SPECIFIED INCORRECTLY	1	1	1			1

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/1/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 2.0 ASSIGN CRANE OPERATOR

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 ASSIGN CRANE OPERATOR	ASSIGN UNQUALIFIED OP	3	2	6			6
	ASSIGN UNAVAILABLE OP	2	1	2			2
	ASSIGN UNWILLING OP	3	1	3			3
n.2							
n.3							
n.4							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High

** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives

*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents

**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/1/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 3.0 PREPARE EQUIPMENT AND CREW

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 SPECIFY RIGGING REQUIRED FOR LIFTS.	INCORRECT RIGGING SPECIFIED	1	1	1			1
	TAG LINES NOT SPECIFIED	4	2	2			2
n.2 CONDUCT PRE-LIFT CRANE INSPECTION	PRE-LIFT INSPECTION NOT CONDUCTED	4	3	12	3		24
n.3 IDENTIFY ON-PLATFORM LIFTS REQ'D. TO BOAT ARRIVAL	FAILURE TO CLEAR DECK FOR LOADS	1	1	1			1
n.4 PERFORM NECESARY ADMINISTRATIVE TASKS	ADMINISTRATIVE TASKS NOT COMPLETED	1	1	1			1

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 4.0 RIG UP CRANE

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 START CRANE	THROTTLE NOT OPEN	1	1	1			1
	EMERGENCY STOP ACTIVATED	1	1	1			1
n.2 RAISE BOOM	BOOM ANGLE TOO HIGH	2	2	4			4
n.3 POSITION CRANE OVER STINGER	BOOM NOT CENTERED OVER STINGER	3	1	3			3
	BOOM ANGLE TOO LOW	3	2	6			6
	FAILURE TO CHECK SWING AREA	2	1	2			2
n.4 SELECT LIFT LINE TO BE USED	SELECT THE WRONG LIFT LINE	2	1	2			2

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 4.0 RIG UP CRANE

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust*** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 LOWER THE HOOK	HOOK LOWERED TOO FAR	2	1	2			2
	HOOK NOT LOWERED FAR ENOUGH	2	1	2			2
	FAILURE TO SET SWING BRAKE WHEN REQ'D	1	2	2			2
n.2 "	LOWER THE WRONG HOOK	3	1	3			3
n.3 ATTACH STINGER	SAFETY LATCH NOT ENGAGED	2	1	2			2
n.4 ATTACH SLINGS OR BASKET	SAFETY LATCH NOT ENGAGED	2	1	2			2

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 5/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 5.0 POSITION CRANE OVER LOAD

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likeli-hood of Error* (1-5)	Conseq-ence of Error** (1-5)	Risk Esti-mate (Col 3*4)	Accident Risk Adjust*** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 RAISE BOOM	SEE TASK 4.0						
n.2 POSITION CRANE OVER LOAD	SEE TASK 4.0						
n.3							
n.4							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 6.0 ATTACH LOAD 1/3

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 LOWER HOOK.	SEE TASK 4.0						
n.2 REMOVE SLING FROM STINGER	LEAVE STINGER ON IN ROUGH SEAS	2	2	4			4
	STINGER HOOK TOO HIGH	3	1	3			3
	STINGER HOOK TOO LOW	3	1	3			3
n.3 RAISE HOOK	RAISE THE WRONG HOOK						
n.4 SWING CRANE TO SAFE LOCATION.	HOOK NOT RAISED HIGH ENOUGH						

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 6.0 ATTACH LOAD 3/3

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 ATTACH SLING TO LOAD	SHACKLE PIN TOO TIGHT	3	1	3			3
	SHACKLE PIN TOO LARGE	3	1	3			3
	SHACKLE EYE TOO SMALL	3	1	3			3
n.2	SHACKLE PIN TOO LOOSE	2	1	2			2
	FAIL TO STRAIGHTEN SLING LINES	2	1	2			2
	CANNOT ATTACH SLINGS	2	1	2			2
n.3 POSITION CRANE OVER LOAD.	SEE TASK 4.0						
n.4 LOWER THE HOOK	LOWER THE HOOK TOO LOW	2	2	4			4
	HOOK NOT LOWERED FAR ENOUGH	2	1	2			2

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 6.0 ATTACH LOAD 3/3

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 ATTACH SLING TO STINGER	FAIL TO ENGAGE HOOK SAFETY LATCH	2	1	2			2
	CANNOT ATTACH SLING TO HOOK	2	1	2			2
n.2 RIGGERS MOVE CLEAR OF LOAD	RIGGERS DON'T MOVE CLEAR	3	3	9	2		18
n.3							
n.4							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 7.0 LIFT LOAD 1/2

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likeli-hood of Error* (1-5)	Conseq-ence of Error** (1-5)	Risk Esti-mate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 TAKE UP LINE SLACK	SLINGS WRAPPED AROUND OBSTACLES	3	2	6	3		18
	TENSION LINE BEFORE BOOM IS CENTERED	3	2	6	2	3	18
	SLACK TAKEN UP TOO QUICKLY	3	2	6			
n.2	WINCH UP THE WRONG LINE	3	2	6	2		12
n.3 CENTER THE BOOM	BOOM NOT CENTERED	3	2	6			
n.4 WINCH UP THE LOAD	WINCH UP IMPROPERLY RIGGED LOAD	2	3	6	3		18

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 1.0 LIFT LOAD 2/2

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust*** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 SWING BOOM CLEAR OF BOAT	DON'T SWING BOOM CLEAR	3	2	6			6
	LOAD NOT CLEAR OF OBSTACLES	3	2	6	2		12
	SWING BOOM WRONG DIRECTION	3	1	3			3
n.2	SWING BOOM TOO FAST	3	2	6			6
	SWING BOOM TOO FAR	2	2	4			4
n.3 RAISE LOAD ABOVE PLATFORM OBSTACLES	WINCH TOO HIGH W/O.O.S ANTI TWO BLOCK	3	2	6	2		12
	BOOM TOO HIGH W/O.O.S BOOM KICK-OUT	3	2	6	2		12
n.4							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 8.0 POSITION CRANE TO LOWER LOAD

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 SWING LOAD OVER CLEAR AREA	BOOM ANGLE TOO LOW	3	2	6			6
	BOOM ANGLE TOO HIGH	3	2	6	3		18
	FAIL TO CHECK SWING AREA	2	1	2			2
n.2							
n.3							
n.4							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 5/2/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 9.0 LOWER & UN-HOOK LOAD

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likeli-hood of Error* (1-5)	Conseq-ence of Error** (1-5)	Risk Esti-mate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 WINCH DOWN THE LOAD	WINCH DOWN TOO FAST	3	2	6	2		12
	WINCH DOWN LOAD ONTO CROWDED DECK	3	2	6			6
n.2 RIGGER UN-HOOKS THE SLING	INSUFFICIENT SLACK IN LINE	2	1	3			3
	RIGGER FAILS TO SECURE SLING ROPES	3	2	6	3		18
	RIGGER IN UNSTABLE POSITION	2	2	4			4
n.3 CRANE OPERATOR UN-HOOKS THE SLING	FAILURE TO SET SWING BREAK	2	2	4			4
	CANNOT SET SWING BREAK	2	2	4			4
n.4 WINCH UP THE HOOK	SLING WRAPPED AROUND OBSTACLES	3	2	6	3		18
	WINCH UP THE WRONG LINE	3	2	6	2		12

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 2/12/..

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 10.0 RIG DOWN CRANE 1/2

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likeli-hood of Error* (1-5)	Conseq-ence of Error** (1-5)	Risk Esti-mate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 SWING OVER RIGGING STORAGE AREA	SEE PREVIOUS						
n.2 WINCH DOWN LINE							
n.3 DETACH SLING OR BASKET							
n.4 SWING OVER STINGER LAYDOWN AREA							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 3/21/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 10.0 RIG DOWN CRANE 2/2

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likeli-hood of Error* (1-5)	Conseq-ence of Error** (1-5)	Risk Esti-mate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 WINCH DOWN LINE	SEE PREVIOUS						
n.2 REMOVE STINGER							
n.3 WINCH UP							
n.4							

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 5/2,17

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: 11.0 SECURE CRANE

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust *** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 BOOM UP	SEE PREVIOUS						
n.2 SWING BOOM OVER CRADLE							
n.3 BOOM DOWN INTO CRADLE	MISS THE CRADLE	2	1	2			2
	BOOM DOWN TOO FAST	3	2	6			6
	FAIL TO LET OUT LOAD LINE	3	2	6			6
n.4 SHUT DOWN CRANE	FAIL TO SHUT DOWN CRANE	2	1	2			2

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 2 - Description of Steps in Tasks

Date: 5/8/97

Activity: OFFSHORE CRANE OPERATIONS

Task Number and Name: POSITIONING LOAD WITH A SIGNALMAN

Description of Steps in Individual Tasks - Error Analysis							
Column 1	Column 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Estimate (Col 3*4)	Accident Risk Adjust*** (Accident Anal)	Incident Risk Adjust**** (Critical Incid)	Modified Risk Value (Larger of number in Col 6 or Col 7 *Col 5)
n.1 POSITION A RIGGER LOAD	RIGGER NOT POSITIONED PROPERLY	1	1	1			1
n.2 POSITION SIGNALMAN TO SEE LOAD	SIGNALMAN CANNOT SEE LOAD	1	1	1			1
n.3 SIGNAL CRANE OPERATOR TO POSITION LOAD	CRANE OPERATOR CANNOT SEE SIGNALS	4	1	4			4
	WRONG SIGNAL GIVEN	3	2	6			6
	UNRECOGNIZABLE SIGNAL	3	1	3			3
n.4 CRANE OPERATOR RESPONDS TO SIGNALS	WRONG RESPONSE TO SIGNAL	3	2	6			6
	OPERATOR MOVES LOAD TOO QUICKLY	3	2	6			6
	OPERATOR MISSES SIGNAL	3	2	6			6

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High
** Consequence of Errors: 1 - Lost Time; 2 - Equip Damage; 3 - Injuries & Major Equip Damage; 4 - Death, Severe Inj, Equip Loss; 5 - Loss of System & Lives
*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents
**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 4: CRITICAL ERRORS Analysis

Date: 3-2-97

** Critical Errors are those which have caused significant loss or if the value in Column 8 of Form 3 is "12" or above

Activity: OFFSHORE CRANE OPERATIONS
3.0
Task: PREPARE EQUIPMENT & CREW

CRITICAL ERRORS ANALYSIS

Step Number and Name	Human Error Description	Error Causation Stage-Check all that apply					Comments
		Info Source	Input Channel	Info Processor	Output Channel	Output Action	
n.1 CONDUCT PRE LIFT CRANE INSPECTIONS.	FAILURE TO CONDUCT PRE LIFT CRANE INSPECTION			X MOTIVATION			OPERATOR MOTIVATED TO GET THE JOB DONE QUICKLY AND DISTRACTED BY OTHER DUTIES.
n.2							
n.3							
n.4							

Form 4: CRITICAL ERRORS Analysis

Date: 3/21/17

** Critical Errors are those which have caused significant loss or if the value in Column 8 of Form 3 is "12" or above

Activity: OFFSHORE CRANE OPERATIONS

Task: 6.0 ATTACH LOAD

CRITICAL ERRORS ANALYSIS							
Step Number and Name	Human Error Description	Error Causation Stage-Check all that apply					Comments
		Info Source	Input CHANNEL	Info Processor	Output Channel	Output Action	
n.1 RIGGERS MOVE CLEAR OF LOAD	RIGGERS DON'T MOVE CLEAR			X SITUATION AWARENESS			LOAD MAY SHIFT IN HEAVY SEAS WHEN CABLE SLACK IS TAKEN UP.
n.2							
n.3							
n.4							

Form 4: CRITICAL ERRORS Analysis

Date: 3-2-91

** Critical Errors are those which have caused significant loss or if the value in Column 8 of Form 3 is "12" or above

Activity: OFFSHORE CRANE OPERATIONS

Task: 7.0 LIFT & LOAD UP

CRITICAL ERRORS ANALYSIS

Step Number and Name	Human Error Description	Error Causation Stage-Check all that apply					Comments
		Info Source	Input CHANNEL	Info Processor	Output Channel	Output Action	
n.1 RAISING THE HOOK (TAKE UP SLACK)	WINCH UP WITH SLING WRAPPED AROUND OBSTACLES	X	X				CANNOT SEE ALL AROUND LOADS OR OBJECTS ON DECK. MAY OCCUR AFTER VISUAL CHECK - JOB OR PROCEDURE REDESIGN
n.2	TENSION BEFORE BOOM IS CENTERED				X	X	DIFFICULTY TRACKING A MOVING TARGET.
n.3	WINCH UP WITH WRONG HOOK.				X		OPERATOR MAY SELECT WRONG LEVER
n.4 WINCH THE LOAD OFF THE DECK.	WINCH UP IMPROPERLY RIGGED LOADS	X					PROBLEM IS CREATED BY RIGGER SIGNALING TO RAISE.

Form 4: CRITICAL ERRORS Analysis

Date: 3/2/91

** Critical Errors are those which have caused significant loss or if the value in Column 8 of Form 3 is "12" or above

Activity: OFFSHORE CRANE OPERATIONS

Task: 7.0 LIFT/LOAD / LAND

CRITICAL ERRORS ANALYSIS

Step Number and Name	Human Error Description	Error Causation Stage-Check all that apply					Comments
		Info Source	Input CHANNEL	Info Processor	Output Channel	Output Action	
n.1 SWING BOOM CLEAR OF BOAT	SWING BOOM BEFORE LOAD CLEARS OBSTACLES ON BOAT		X	X		X	SLOW LOAD LIFT MAY CAUSE PROBLEMS AS BOAT SHIFTS.
n.2 RAISE LOAD ABOVE PLATFORM OBSTACLES.	WINCH UP TOO HIGH WITH O.O.S ANTI-TWO BLOCK.			X			OPERATOR WATCHING LOAD - NOT BALL OR BLOCK. SAFETY DEVICE INOPERABLE - SEE TASK 3.
n.3 "	BOOM UP TOO HIGH WITH KICKOUT O.O.S.			X			OPERATOR WATCHING LOAD - NOT BOOM ANGLE. SAFETY DEVICE INACTIVE SEE TASK 3
n.4							

Form 4: CRITICAL ERRORS Analysis

Date: 3-3-97

** Critical Errors are those which have caused significant loss or if the value in Column 8 of Form 3 is "12" or above

Activity: OFFSHORE CRANE OPERATIONS

Task: 8.0 POSITION CRANE TO LOWER LOAD

CRITICAL ERRORS ANALYSIS

Step Number and Name	Human Error Description	Error Causation Stage-Check all that apply					Comments
		Info Source	Input	Info Processor	Output Channel	Output Action	
n.1 SWING LOAD OVER CLEAR AREA	BOOM ANGLE TOO HIGH			X			SEE TASK 7.0
n.2							
n.3							
n.4							

Form 4: CRITICAL ERRORS Analysis

Date: 3-29-1

** Critical Errors are those which have caused significant loss or if the value in Column 8 of Form 3 is "12" or above

Activity: OFFSHORE CRANE OPERATIONS

Task: 9.0 LOWER & UN-HOOK LOAD

CRITICAL ERRORS ANALYSIS

Step Number and Name	Human Error Description	Error Causation Stage-Check all that apply					Comments
		Info Source	Input CHANN	Info Processor	Output Channel	Output Action	
n.1 WINCH DOWN THE LOAD	WINCH DOWN TOO FAST			X		X	
n.2 RIGGER UN-HOOKS THE SLINGS	RIGGER FAILS TO SECURE SLING ROPES			X			SLING ROPE CAN SWING AND STRIKE RIGGER
n.3 WINCH UP THE HOOK	SLING WRAPPED AROUND OBSTACLES	X					RIGGER SIGNALS TO RAISE
n.4 "	WINCH UP THE WRONG LINE				X		OPERATOR MOVES THE WRONG LEVER.

Form 5 - Description of Steps in Tasks

Date: 3-4-97

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
FAILURE TO CONDUCT PRE-LIFT CRANE INSPECTIONS

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO CHANNEL

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: ADVANCED NOTIFICATION OF BOAT ARRIVAL NOT RECEIVED
1 2 3 (4) 5
Low Medium High

2:
1 2 3 4 5
Low Medium High

3:
1 2 3 4 5
Low Medium High

4:
1 2 3 4 5
Low Medium High

Potential Remedial Measures

1. a) PROVIDE BACKUP SHIP-TO-PLATFORM COMMUNICATION TO ENSURE ADVANCED WARNING IS RECEIVED.

2.

3.

4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
FAILURE TO CONDUCT PRE-LIFT CRANE INSPECTIONS

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO PROCESSOR

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

		1 Low	2	3 Medium	4	5 High
1:	WORKLOAD - TIME CONSTRAINTS			(3)		
2:	CONSEQUENCE SEVERITY IS PERCEIVED TO BE MINOR (IGNORED)				(4)	
3:						
4:						

Potential Remedial Measures

1. ESTABLISH AND/OR ENFORCE PROCEDURE TO CONDUCT DAILY CRANE CHECKS DURING SLACK PERIODS.
2. IMPROVE TRAINING AND SUPERVISION. ESTABLISH MANDATORY CHECKPOINTS IN PROCEDURE TO "TICKLE" COMPLIANCE
3.
4.

orm 5 - Description of Steps in Tasks

Date: 3-4-97

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
RIGGERS ON BOAT DON'T MOVE CLEAR AFTER ATTACHING LOAD

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO PROCESSOR

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: INEXPERIENCED/UNTRAINED RIGGERS	1 Low	2	(3) Medium	4	5 High
2:	1 Low	2	3 Medium	4	5 High
3:	1 Low	2	3 Medium	4	5 High
4:	1 Low	2	3 Medium	4	5 High

Potential Remedial Measures

1. ENSURE AVAILABILITY OF TRAINED RIGGERS THROUGH MANPOWER PLANNING OR CONTRACT SPECIFICATIONS
2.
3.
4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
RAISE THE WRONG HOOK (WHEN ATTEMPTING TO TAKE UP SLACK)

STEP TWO: EC2 — List Potential Error Causes

Source of error: OUTPUT CHANNEL

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: CONFUSION BETWEEN LOAD LINE AND FAST LINE CONTROLS
1 2 (3) 4 5
Low Medium High

2: _____
1 2 3 4 5
Low Medium High

3: _____
1 2 3 4 5
Low Medium High

4: _____
1 2 3 4 5
Low Medium High

Potential Remedial Measures

1. MODIFY CRANE CONTROLS TO ENHANCE CONTROL DIFFERENTIATION
2.
3.
4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
SLING WRAPPED AROUND OBSTACLES (WHEN RAISING HOOK)

STEP TWO: EC2 — List Potential Error Causes

Source of error: INPUT CHANNEL

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: CROWDED BOAT DECK (DISTORTION, DISRUPTION)	1 Low	2	3 Medium	(4)	5 High
2: INEXPERIENCED/UNTRAINED RIGGERS	1 Low	2	(3) Medium	4	5 High
3: POOR ILLUMINATION (NIGHT OPS) (DISTORTION, DISRUPTION)	1 Low	2	(3) Medium	4	5 High
4:	1 Low	2	3 Medium	4	5 High

Potential Remedial Measures

1. DEVELOP AND IMPLEMENT SPECIFICATIONS FOR CARGO SPACING ON BOAT DECKS.
2. ENSURE AVAILABILITY OF TRAINED RIGGERS THROUGH MANPOWER PLANNING OR CONTRACT SPECIFICATIONS.
3. INSTALL AND/OR MAINTAIN BOOM LIGHT SYSTEMS.
4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
TENSION APPLIED BEFORE BOOM IS CENTRED OVER LOAD

STEP TWO: EC2 — List Potential Error Causes

Source of error: OUTPUT CHANNEL

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: CONFUSION BETWEEN WINCH CONTROL AND BOOM CONTROL LEVERS
1 2 (3) 4 5
Low Medium High

2: _____
1 2 3 4 5
Low Medium High

3: _____
1 2 3 4 5
Low Medium High

4: _____
1 2 3 4 5
Low Medium High

Potential Remedial Measures

1. MODIFY CRANE CONTROLS TO ENHANCE CONTROL DIFFERENTIATION.
2.
3.
4.

orm 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
TENSION APPLIED BEFORE BOOM IS CENTERED OVER LOAD

STEP TWO: EC2 — List Potential Error Causes

Source of error: OUTPUT ACTION

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: LOAD IS MOVING IN 3 DIMENSIONS (HIGH SEAS)
1 2 3 (4) 5
Low Medium High

2: BAD COORDINATION BETWEEN BOAT AND CRANE OPERATOR
1 (2) 3 4 5
Low Medium High

3: _____
1 2 3 4 5
Low Medium High

4: _____
1 2 3 4 5
Low Medium High

Potential Remedial Measures

1. DEVELOP AND IMPLEMENT CRITERIA FOR CONDUCTING LIFTS TO AND FROM SERVICE VESSELS IN HIGH SEAS AND ADVERSE WEATHER.
2. PROVIDE CONTINUOUS "HANDS-FREE" COMMUNICATION BETWEEN CRANE OPERATOR AND BOAT CAPTAIN.
3.
4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
WINCH UP IMPROPERLY RIGGED LOADS 1/2

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO SOURCE

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

		1 Low	2	3 Medium	4	5 High
1:	IMPROPER SLING SELECTION		(2)			
2:	SLINGS NOT PROPERLY ATTACHED / INEXPERIEND RIGGERS			(3)		
3:	USING DAMAGED SLING. (FAILURE TO INSPECT SLING)		(2)			
4:	FAILURE TO LOAD TEST NEW SLING BEFORE PLACING IN SERVICE.		(2)			

Potential Remedial Measures

1.

2. ENSURE AVAILABILITY OF TRAINED RIGGERS THROUGH MANPOWER PLANNING OR CONTRACT SPECIFICATIONS.

3.

4. ESTABLISH AND IMPLEMENT AND/OR ENFORCE PRACTICE TO LOAD TEST ALL NEW SLINGS AT ON-SHORE FACILITIES BEFORE THEY ARE DELIVERED OFFSHORE.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
WINCH UP IMPROPERLY RIGGED LOADS 2/2

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO SOURCE

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: INCORRECT SLING ANGLE — (2) (1 Low, 3 Medium, 4, 5 High)

2: HOOK NOT ABOVE LOAD CENTER OF GRAVITY. — (3) (1 Low, 2, 3 Medium, 4, 5 High)

3: _____ — (1 Low, 2, 3 Medium, 4, 5 High)

4: _____ — (1 Low, 2, 3 Medium, 4, 5 High)

Potential Remedial Measures

1. OR PRE-SLING

2. DEVELOP SPECIFIC RIGGING PROCEDURES FOR OFF-BALANCE LOADS (SUCH AS COIL TUBING MACHINES) THAT ARE FREQUENTLY LIFTED.

3.

4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
SWING BOOM BEFORE LOAD CLEARS OBSTACLES. (AFTER SNATCHING)

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO. PROCESSOR

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: SNATCHING HEAVY LOAD FROM BOAT USING SLOW LOAD LINE

1 (2) 3 4 5
Low Medium High

2: LIFTING LOADS FROM VESSEL IN ROUGH SEAS.

1 2 3 (4) 5
Low Medium High

3: _____

1 2 3 4 5
Low Medium High

4: _____

1 2 3 4 5
Low Medium High

Potential Remedial Measures

1. DEVELOP AND IMPLEMENT CRITERIA FOR CONDUCTING LIFTS TO AND FROM SERVICE VESSELS IN HIGH SEAS AND ADVERSE WEATHER.
2.
3.
4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error: WINCH UP TOO HIGH (W/ O.O.S. ANTI-TWO BLOCK)

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO PROCESSOR

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: PRE-LIFT CRANE INSPECTION NOT PERFORMED — 1 Low 2 3 Medium (4) 5 High

2: _____ — 1 Low 2 3 Medium 4 5 High

3: _____ — 1 Low 2 3 Medium 4 5 High

4: _____ — 1 Low 2 3 Medium 4 5 High

Potential Remedial Measures

1. a) PREVIOUS RECOMMENDATION
   b) ENFORCE PROHIBITION AGAINST USING CRANES WITH O.O.S. ANTI-TWO BLOCK DEVICES
2.
3.
4.

orm 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
BOOM UP TOO HIGH (W/ O.O.S. BOOM KICKOUT)

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO PROCESSOR

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: PRE-LIFT CRANE INSPECTION NOT PERFORMED
1 2 3 (4) 5 — Low Medium High

2: _____
1 2 3 4 5 — Low Medium High

3: _____
1 2 3 4 5 — Low Medium High

4: _____
1 2 3 4 5 — Low Medium High

Potential Remedial Measures

1. PREVIOUS RECOMMENDATIONS.
2.
3.
4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
WINCH LOAD DOWN TOO FAST

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO PROCESSOR

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: OPERATOR UNDER TIME CONSTRAINTS - RUSHED — 1 Low 2 3 Medium 4 5 High

2: — 1 Low 2 3 Medium 4 5 High

3: — 1 Low 2 3 Medium 4 5 High

4: — 1 Low 2 3 Medium 4 5 High

Potential Remedial Measures

1.

2.

3.

4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
WINCH LOAD DOWN TOO FAST

STEP TWO: EC2 — List Potential Error Causes

Source of error: OUTPUT ACTION

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: OPERATOR MOVES WINCH DOWN LEVER TOO FAR.
1 Low (2) 3 Medium 4 5 High

2: _____
1 Low 2 3 Medium 4 5 High

3: _____
1 Low 2 3 Medium 4 5 High

4: _____
1 Low 2 3 Medium 4 5 High

Potential Remedial Measures
1.
2.
3.
4.

Form 5 - Description of Steps in Tasks

Date: _____

Instructions: Use one copy of this form for each Critical Error Identified in HEPA Forms 1-4. In Step 2, identify all possible error causes, no matter how likely they may seem. In the final step, rate the likelihood of each error cause. Use the results to identify possible Remediation measures.

STEP ONE: EC1 — Describe the Critical Error

Critical Error:
RIGGER FAILS TO SECURE SLING ROPES (WHEN DETACHING LOAD)

STEP TWO: EC2 — List Potential Error Causes

Source of error: INFO PROCESSOR

STEP 3: EC3 — Rate the Likelihood of Each Potential Cause

1: RIGGER NOT AWARE THAT SLING ROPES MAY BE FREE SWINGING.
1 2 (3) 4 5 — Low / Medium / High

2: INEXPERIENCED/UNTRAINED.
1 2 3 4 5 — Low / Medium / High

3:
1 2 3 4 5 — Low / Medium / High

4:
1 2 3 4 5 — Low / Medium / High

Potential Remedial Measures

1. ENSURE AVAILABILITY OF TRAINED RIGGERS THROUGH MANPOWER PLANNING OR CONTRACT SPECIFICATIONS.
2.
3.
4.

Form 2: GROSS TASK ANALYSIS AND ERROR IDENTIFICATION

Activity: _____ Date: _____

Task Number and Name: _____

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Step Number and Name	Human Error Description	Likelihood of Error* (1-5)	Consequence of Error** (1-5)	Risk Index (3) * (4)	Adjustment Factor***	Modified Risk Index (5) * (6)
_____._____						
_____._____						
_____._____						
_____._____						

* Likelihood of Errors: 1 - Low; 3 - Medium; 5 - High

** Consequence of Errors: 1 - Operational delays; 2 - Equipment Damage; 3 - Injuries and Major Equipment Damage; 4 - Death, Severe Injuries; 5 - Multiple Fatalities

*** Risk Adjustment Factor: 1 - No accident experience; 2 - Few Accidents; 3 - Frequent Accidents

**** Risk Estimate Adjustment Factor: 1 - No Incident Experience; 2 - Few Incidents; 3 - Frequent Incidents

Form 3: ERROR ANALYSIS AND CORRECTIVE MEASURES

Activity: _____ Date: _____

Task Number and Description: _____

Step Number and Description: _____

Error Description: _____

Errors by Information Processing Stage
Check all that apply

Stage / Error	Information Source	Information Reception	Decision/Response	Output Action	Comments
No Action	1 ☐ Not present or below threshold	2 ☐ Operator limitation 3 ☐ Environmental interference	4 ☐ Inattention 5 ☐ Information ignored 6 ☐ Unaware of correct response	7 ☐ Lack of ability	
Late Action	8 ☐ Late availability	9 ☐ Delayed reception	10 ☐ Delays in processing	11 ☐ Delayed action	
Wrong Action	12 ☐ Incorrect information	13 ☐ Incorrect of incomplete reception	14 ☐ Selects wrong action 15 ☐ Selects wrong control device	16 ☐ Wrong sequence 17 ☐ Action not sustained or incomplete	

Cause of Error From Above	Likelihood of Cause (Low 1 2 3 4 5 High)	Possible Corrective Action (See Table)	Comments
	1 2 3 4 5		
	1 2 3 4 5		
	1 2 3 4 5		
	1 2 3 4 5		

APPENDIX C
REVISED HUMAN ERROR ASSESSMENT TOOL
Dated March 1997

Joint Industry Project on

Human Factors in Offshore Operations

HUMAN ERROR POTENTIAL ASSESSMENT TOOL

Draft Version B

EQE Project Number 59122

March 1997

TABLE OF CONTENTS

TABLES

FORMS

INTRODUCTION

The Human Error Assessment Tool (HEAT) is designed to allow teams of trained users to examine activities from a Human Factors (HF) perspective. The purpose of the HEAT is to identify possible system-induced human errors, prioritize these errors based on relative financial or safety impact, and analyze critical errors using an HF model in order to identify appropriate corrective measures for improving system performance.

SCOPE

Although the HEAT can be applied to any system, the goal of the JIP is to design a tool that is appropriate to the culture and resource availability of the offshore oil and gas industry.

LIMITATIONS

The HEAT is a systematic approach to analyzing an activity for human error. However, the user should not expect that application of human error assessment will identify and correct all possible sources of human error in a system. The value of human error assessment lies in the insight into the causes of human error that the analysis provides. This insight results in a unique perspective on how to modify an activity or system to reduce the potential for damaging human error.

Unfortunately, human error assessment cannot be used as the **single** tool for identifying system improvements. The HEAT compliments other hazard identification tools such as hazard and operability studies (HAZOP), fault tree analysis, event tree analysis,

etc. The user will notice some similarities between the HEAT and these other hazard identification methods. When used appropriately and in conjunction with these other tools, human error assessment can help identify unique, cost-effective measures for system improvement.

GENERAL APPROACH

The approach involves examining the individual steps that people perform when conducting an activity in order to identify potential human errors. Once identified, each error is then subjectively analyzed and rated for its potential impact to system performance as well as its likelihood of occurrence. Rating the errors provides a means to prioritize the application of corrective measures for error reduction. High-priority, or critical, errors are the focus of the human factors error analysis, since eliminating these errors will result in the greatest overall system improvement.

Application of the HEAT involves three steps (Gross Task Analysis, Human Error Identification, and Error Analysis and Corrective Measures) that attempt to answer the following questions:

Gross Task Analysis

1. What is the activity of interest?
2. What are the major tasks performed in the activity?
3. What are the steps performed in each major task?

Human Error Identification

4. What are the potential errors for each step?

5. How likely is each error?

6. What is the consequence of each error?

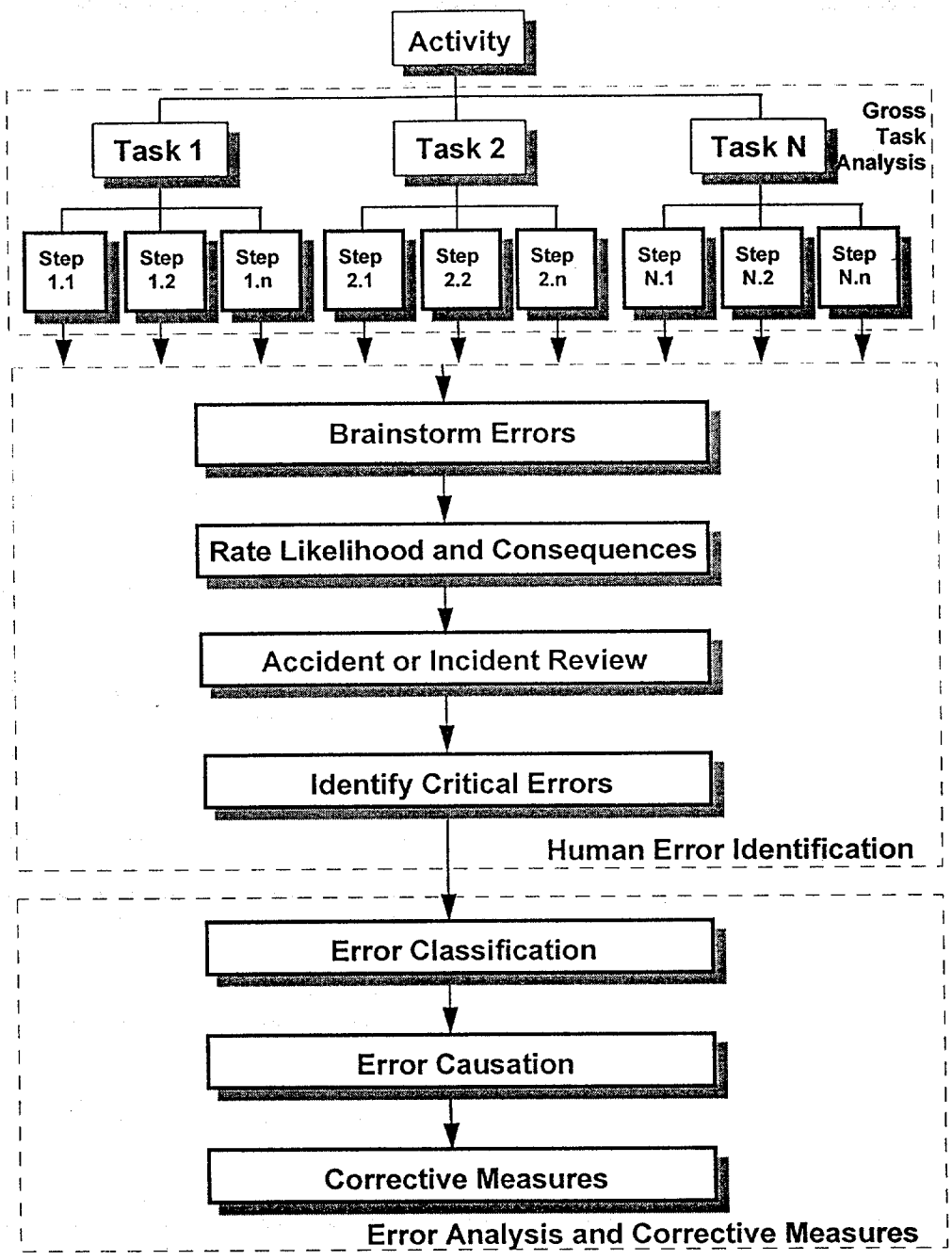
7. Which are the critical errors?

Error Analysis and Corrective Measures

8. What are the human factors cause(s) these errors?

9. What are some appropriate corrective measures?

An overview of the of the HEAT is presented below:


Activity
Gross Task Analysis
Task 1
Task 2
Task N
Step 1.1
Step 1.2
Step 1.n
Step 2.1
Step 2.2
Step 2.n
Step N.1
Step N.2
Step N.n
Brainstorm Errors
Rate Likelihood and Consequences
Accident or Incident Review
Identify Critical Errors
Human Error Identification
Error Classification
Error Causation
Corrective Measures
Error Analysis and Corrective Measures

GROSS TASK ANALYSIS

Gross Task Analysis is used to develop an outline of the procedure that is followed when conducting the activity under study. If detailed written procedures are available for the activity, the Gross Task Analysis is not necessary as the procedures can be used directly in Human Error Identification.

Gross Task Analysis involves the following steps

- Define the study scope
- Break the activity down into tasks
- Break each task down into the steps needed to perform the task

Define Study Scope

Defining the study scope involves setting the boundaries of the activity to be studied. This can be done by identifying the initial and final state of the system. For example, consider the following initial state:

- Cargo basket located on the deck of a service vessel
- Platform crane shut down with boom resting in the boom cradle

And the following final state:

- Cargo basket located on platform deck
- Platform crane shut down with boom resting in the boom cradle

Based on the above conditions, the activity to be studied could be described as "moving a cargo basket from the deck of a service vessel to the platform using the platform crane." Since the initial and final condition of the crane is that it is shut down with the boom resting in the boom cradle, the activity scope will include crane startup and shutdown.

GROSS TASK ANALYSIS

Tasks

Tasks are the individual functions necessary to accomplish an activity. Tasks can be performed by either a human or a machine, separately or in combination. They represent the first level of the procedural outline and should be stated in broad terms. Some examples of tasks in crane operation are:

- Position crane to a predetermined location
- Attach load
- Lift load
- Position load to a predetermined location
- Lower load
- Detach load

Steps

Steps are the actions necessary to complete a task. The process of identifying steps is analogous to that of identifying tasks. Examples of steps involved in positioning a crane to a predetermined location are:

- Select location to move crane
- Visually acquire location
- Operate crane controls to move/positions/lower crane

Gross Task Analysis Procedure

Resource Requirements	• An evaluation team of three or more people, at least one of whom is knowledgeable about the activity being analyzed. • Job or task descriptive information such as written procedures, written training materials, training videos, etc. • Meeting room • Flip chart with colored writing pens • White board with scanner (optional)
Preparation	If written procedures for the activity are available, these procedures can be used in lieu of the Gross Task Analysis. It may be appropriate to break procedures down into manageable tasks. This should be done by the team leader prior to holding the first team session. Copies of the existing procedure, broken down into the tasks, should be available for each team member.
	Discuss the activity to be studied with evaluation team members or management personnel. Define the initial and final state of the system.
	Record the activity description including the scope of the study on Form 1, "Human Error Assessment Summary."
	Using the check list on Form 1, determine which information and other resources are necessary to conduct the study.
	Obtain or generate the necessary information and resources prior to the initial evaluation team meeting.
	If the written procedures are to be used in lieu of the Gross Task Analysis, generate a task list prior to the first team session.

Gross Task Analysis Procedure

Identify Tasks	Discuss the activity with the subject matter experts. Evaluation team members should ask questions and thoroughly discuss the activity so that everyone on the team has a good understanding of the activity.
	If possible, the evaluation team members should observe the activity being conducted. A simulation such as a training video can also be used to familiarize all team members with the activity.
	Using a flip chart or white board, list the major tasks associated with the activity in the sequence order that they are normally performed.
Identify Steps	Transfer the first task to a blank flip chart page.
	List the steps required to complete the task in the sequence order that they are normally performed.
	Continue in the above manner until a list of steps has been developed for each of the identified tasks.

HUMAN ERROR IDENTIFICATION

The objective of Human Error Identification is to identify critical human errors that can occur during the activity under study. A critical error is an error that has an associated high risk index, which is a combination of both the likelihood of error occurrence and severity of the error outcome.

Identifying critical errors is accomplished via several techniques:

- Brainstorm possible errors associated with each procedural step
- Rate the likelihood of error occurrence and the most likely consequence to obtain a base risk index.
- Verify and expand the error list by reviewing historical accident data or interviewing additional personnel.
- Modify the base risk index based on the findings of the accident review or personnel interviews.
- Compare the modified risk index to an arbitrary cutoff value. Critical errors are those with modified risk indices greater than the cutoff value.

Brainstorm Errors

Human errors are identified by examining the requirements of proper step performance and then generating a negative statement for the requirement. For example, if the step requirement is "open valve A by 1/2 turn"

A person could make several errors such as:

- Operator closes valve A by 1/2 turn
- Operator fails to adjust valve A
- Operator opens valve A by an excessive amount

Assign Risk Index	Once possible errors have been listed, the likelihood of making the error and the impact of making the error are rated. This rating process provides insight as to how tolerant a system is to error as well as how the system design (system being the hardware and organization support systems) influences error likelihood. Critical errors then become those errors that are: • Reasonably likely to occur • Not tolerated well by the system
Verify and Expand Error List	Brainstorming errors is subjective in that the results of the brainstorming session will be dependent on the knowledge and experience of the meeting participants. To ensure that error identification is as thorough as possible, the knowledge base can be expanded by: • Reviewing information on past accidents related to the activity • Interviewing additional personnel familiar with the routine performance of the activity Where accident data is available, reviewing this data is the most efficient way to verify the initial error identification. When such data is not available, interviewing 3-5 personnel that did not participate in the brainstorming will usually provide sufficient verification of the brainstorming results.

Modify Base Risk Index and Identify Critical Errors

The base risk index determined during the brainstorming is based on the likelihood and consequence ratings provided by the evaluation team. The accident data review or personnel interviews provide additional insight as to the likelihood and consequence of a given error.

To incorporate this new insight, the base risk index is modified by a factor that depends on the estimated frequency of occurrence during past operation. While this type of modification may not be appropriate for other types of hazard analysis, it is used here in order to more heavily weight system-induced errors which:

1. Are likely to happen

2. Can be reduced by modifying the system

Idiosyncratic errors, which are not system-induced, may account for a large number of the total errors that occur in a system. However, since these errors are more a function of the individual performing the activity, there will probably not be large clusters of the same error. System-induced errors, by definition, will occur with greater detectable frequency because they are an indication of a mis-match between human capabilities and the requirements of the system.

The risk index adjustment factor for each critical error is chosen based on the past frequency of occurrence for the error as follows:

1. Little or no previous accident or incident experience

2. Some previous accident or incident experience

3. Frequent previous accident or incident experience

Human Error Identification Procedure	
Resource Requirements	• The evaluation team • Any available accident data for this activity • 3-5 personnel experienced in the activity (if interviews will be conducted) • Several copies of Form 2, "Gross Task Analysis and Error Identification"
Prepare Forms	For each task identified in the Gross Task Analysis, prepare one copy of Form 2, "Gross Task Analysis and Error Identification" by writing the task description in the appropriate location on the form.
Brainstorm Errors	Select a task.
	Enter the description of the first step under the subject Task in Column 1.
	Brainstorm human errors that can occur during the performance of the listed step. Enter each error into Column 2, one error per line.
Determine Risk Index	For each identified error, assign a rating for the likelihood of error occurrence in Column 3. The likelihood scale ranges from 1 to 5, with 1 being low likelihood and 5 being high likelihood.

	Enter a rating for the consequence of the error in Column 4. The consequence ratings range from 1 to 5 and have the following meaning: 1. Operational delays 2. Equipment damage 3. Injuries and/or major equipment damage 4. Severe injury fatality 5. Catastrophic event with possible multiple fatalities
	Calculate the base risk index by multiplying the likelihood rating (Column 3) by the consequence rating (Column 4). Enter the result in Column 5.
	When all errors identified for this step have been assigned a risk index, proceed to the next step for this task.
	When all steps for this task have been reviewed, proceed to the next task.
Accident Data Review	For each accident record, determine which of the previously identified errors was involved in the accident.
	If a human error that was not previously identified was involved in the accident, add the error description into the proper location on Form 2.
	Count the number of times each error was involved in an accident.

	Assign a risk index adjustment factor to each error based on the following scale: 1. Little or no previous accident experience 2. Some previous accident experience 3. Frequent previous accident experience
	Enter the adjustment factor in Column 6.
	Calculate the modified risk index for each error by multiplying the value in Column 5 by that in Column 6. Enter the result in Column 7.
Personnel Interviews	Using the interview guideline questions provided in Table 1, interview personnel regarding their past involvement with the activity. The goal of the interview is to determine the types of errors that people frequently make when performing the activity, regardless of whether the error resulted in an accident. These errors may have resulted in "near miss" incidents that were not formally documented.
	If a human error that was not previously identified was involved in the incident, add the error description into the proper location on Form 2.
	Count the number of times each error was involved in an incident or was brought up by interviewees.

	Assign a risk index adjustment factor to each error based on the following scale: 1. Little or no previous incident experience 2. Some previous incident experience 3. Frequent previous incident experience
	Enter the adjustment factor in Column 6.
	Calculate the modified risk index for each error by multiplying the value in Column 5 by that in Column 6. Enter the result in Column 7.
Identify Critical Errors	Review the modified risk index for each of the identified errors. If the modified risk index is 12 or more, classify the error as critical and review it using the Error Analysis and Corrective Measures Procedures.

Information Processing Model

The ultimate goal of the HEAT is to identify possible corrective measures for system-induced human errors. In order to develop effective corrective measures, specific causes of these errors must be understood.

In order for a person to successfully interface with a machine or processing system, the following must occur:

- The information required to prompt the operator to take an action must be available at detectable levels.
- The required information must be accurately received by the operator within the required time frame for action.
- The operator must interpret the information and choose the correct response.
- The operator must properly manipulate the machine or process to implement the correct response.

An information processing model can be used to classify human errors into the following categories that correspond to the above bullets:

- Information source errors
- Information reception errors
- Decision/response errors
- Action errors

Information Source	Information sources provide data that the operator must receive in order to take appropriate action. Information sources can include both direct information from • the machine • an object • a signal person, or indirect information provided by • visual displays • auditory displays, etc.
Information Reception	Information reception includes both the transmission mode for the information as well as how the operator perceives the information. Transmission mode may include such items as line-of-sight to the information, background noise (when the information source is auditory), communication systems such as telephone or two-way radio, etc. Operator perception is via one or more of the five senses: sight, hearing, touch, smell, and taste.
Decision/ Response	Decision/response includes interpretation of the information based on memory, skills, attention, and higher level reasoning skills. It also involves selecting the correct response to the information based on all of the above.
Action	Action is the controlled movement of muscles to manipulate controls and affect the proper change to the system.

Error Classification

To better understand the causes of error, the error is classified based on the information processing model. The Error Classification Matrix in Table 2 relates the manifestation of an error (no action, late action, wrong action) to the information processing model via descriptive text. For example, if a person does not take required action, if may be for one or more of several reasons:

- The information needed to prompt the action is not available.
- The person does not receive the information due to a physiological limitation (receptor limitation) or an environmental disturbance that prevents or disrupts information transmission from the source to the receptor.
- The person ignores or mis-interprets information and, as a result, does not recognize the need for action.
- The person receiving the information does not have the ability or skill to perform the required action.

The value of error classification ultimately lies in identification of corrective measures designed to correct the faulty stage of information processing, thus eliminating the system-induced cause of error.

Error Causation

The Corrective Measures Matrix (Table 3) provides guidelines for developing corrective measures based on the error classification. The corrective measures suggested in this matrix are generic and must be considered in light of the specific activity under study.

A human error can result from one or more system-related causes. However, it is common that overall error occurrence is dominated by relatively few specific causes. As a result, it may not be necessary, or appropriate, to equally weigh each identified cause of error.

To focus resources on those causes that dominate error occurrence frequency, the HEAT requires the evaluation team to rate the likelihood of occurrence for each specific cause. Although it may be possible to suggest corrective measures for each cause, the greatest benefit toward error control will be achieved by focusing on high likelihood causes. The cutoff suggested by the JIP is to focus on causes with a likelihood rating of 3-5.

Error Analysis and Corrective Measures Procedures

Resource Requirements	• The evaluation team • All or the previously completed forms • Form 3, "Error Analysis and Corrective Measures" • Error Classification Matrix (Table 2) • Corrective Measures Matrix (Table 3)
Prepare Forms	Prepare Form 3, "Error Analysis and Corrective Measures," for each of the identified critical errors. Include the task in which the error occurs, the step in which the error occurs, a description of the error, and the modified risk index for the error.
Classify Errors per HF Model	Classify the errors according to the information processing model using the Error Classification Matrix (Table 2) on Form 3. Check all boxes in this matrix that apply to the identified error.
Identify Causes of Error	For each box checked in the error classification matrix, list the possible causes of the error on the bottom section of Form 3. Attach additional forms if necessary.
Rate Likelihood	Rate the likelihood that each specific cause will result in the error of concern. The likelihood ranges from a low of 1 to a high of 5.
Suggest Corrective Measures	Suggest appropriate corrective measures for each cause that is assigned a likelihood rating of 3, 4, or 5. The Corrective Measures Matrix (Table 3) provides guidelines for appropriate corrective measures based on the error classification. Corrective measures, whenever possible, should focus on correcting the cause of the error.
	Note any comments related to the cause or suggested corrective measure.

Table 1

PERSONNEL INTERVIEW GUIDELINES

Critical Incident Questions

1. Can you think of a situation in which an accident occurred or almost occurred while performing this task?
2. What were the general circumstances leading up to this incident?
3. How often has this occurred?
4. Was there some action or inaction by the people involved that contributed to the incident?
5. When did this occur?
6. What was your role in the activity?
7. How long have you been performing this task?
8. What needs to be done to prevent this type of accident?
9. What would you do if this type of accident occurred?
10. Other comments?

Table 2: ERROR CLASSIFICATION MATRIX

Information Processing Stage	Description of Stage	Information Processing Mechanisms	Type of Error		
			No Action	Late Action	Wrong Action
Information Source	Information provide data that the operator must receive in order to take appropriate action	Direct information from: Machine, object or person (sight, sound, movement, temp, smell, pressure, vibration) Indirect: Visual displays (gage, dial, lights, knob position) Auditory displays (sirens, horns)	Sources Information not present or not detectable (below human sensory threshold)	Source information not present at right time	Source information incorrect
Information Reception	Source information must be received by accomplished by specialized human sensory mechanisms • Transmission of information from the information sources to the human receptor • Proper reception of the information by the receptor	Sense: Vision - color, hue brightness, line-of-sight Sound - pitch, loudness Touch - vibration, temp, pressure Smell, Taste, Body Position, and Movement	Information cannot be received by specific operator (deaf, color blind) Information cannot be received because of environmental conditions (noise, darkness, brightness, weather)	Information delayed because of difficulties in reception	Incomplete reception because of distortion, disruption or distraction
Decision/ Response	Information received is used to invoke rules of reasoning in order to select a response	Attention (determining which information received is important) Memory (of learned rules and experience) Comparison (of received information with expected) Response generation (selecting response and action sequence)	Information not attended to (distracted, fatigue) Information ignored (not considered important) Not aware of correct response (faulty learning or experience)	Delays in processing (high workload, fatigue, stress, physiological condition)	Selects wrong action (incomplete learning or experience) Selects wrong control device
Action	Controlled movement of muscles to effect a change in the machine or process	Ability (action in within the capability of individual) Skill (training and practice to perform action successfully) Endurance (can sustain action)	Action not within ability	Slow to act (lack of practice of experience)	Wrong sequence - timing errors (lack of skill) Cannot sustain action (lack of endurance)

Table 3: CORRECTIVE MEASURES MATRIX

Information Processing Stage	Type of Error	Possible Corrective Measure(s)
	No Action (E1)	
Information Source	1 Source information not present or not detectable (below human sensory threshold)	1 Provide information above detection threshold
Information Reception	2 Information cannot be received by specific operator (deaf, color blind)	2 Define required personnel attributes in fitness testing
	3 Information cannot be received because of environmental conditions (noise, darkness, brightness, weather)	3 Control environment; seek another sensory receptor; make information redundant (more than one source)
Decision/Response	4 Information not attended to (distracted, fatigue)	4 Reduce workload; improve rest cycles or shift pattern; provide pre-alerting signal before vital information is presented
	5 Information ignored (not considered important)	5 Procedural training and supervision. Mandatory checkpoints - flag removal
	6 Not aware of correct response (faulty learning or experience)	6 Training and practice
Action	7 Action not within ability	7 Define required personnel attributes; fitness testing
	Late Action (E2)	
Information Source	8 Source information not present at right time	8 Improve information flow or communications. Improve task sequencing.
Information Reception	9 Information delayed because of difficulties in reception	9 Improve source intensity; reduce background interference
Decision/Response	10 Delays in processing (high workload, fatigue, stress, physiological condition)	10 Reduce workload; improve rest cycles or shift pattern; provide pre-alerting signal before vital information is presented; increase supervision
Action	11 Slow to act (Lack of practice or experience)	11 Improve skills with "hands-on" training or frequent drills
	Wrong Action (E3)	
Information Sources	12 Source information incorrect	12 Provide correct information
Information Response	13 Incompletely processed because of distortion, disruption, or distraction	13 Reduce demands of competing tasks; improve communications system; provide training for information priority
Decision/Response	14 Select wrong action (Incomplete learning or experience)	14 Improve training; conduct frequent drills
	15 Selects wrong control device	15 Modify the control display or configuration to improve differentiation
Action	16 Wrong sequence - timing errors (Lack of skills)	16 Improve control sequence identification; conduct frequent drills
	17 Cannot sustain action (Lack of endurance)	17 Define required personnel attributes; fitness testing; improve training; redesign job

Form 1: HUMAN ERROR ASSESSMENT SUMMARY

Study Scope
Describe the State(s) of System Prior to Conducting the Activity:
Describe the State(s) of the System at Completion of the Activity:
From the Above, Create a Concise Statement of Scope for this Human Error Assessment:

Evaluation Team
List the Names and Titles of the Evaluation Team Members. Circle the Name of the Evaluation Team Leader

Study Preparation Checklist

The following checklist can be used for study planning purposes. Check off items needed for the study and obtain before the first evaluation team meeting

Item	Required?	Arranged	Item	Required	Arranged
Team members	☐	☐	Copies of Blank Heat Forms	☐	☐
Written Procedures	☐	☐	Accident Data for the Activity	☐	☐
Training Materials	☐	☐	Access to Personnel for Interviews	☐	☐
_____	☐	☐	Interview Guideline Questions (Table 1)	☐	☐
_____	☐	☐	Error Classification Matrix	☐	☐
_____	☐	☐	Corrective Measures Matrix	☐	☐
Meeting Room	☐	☐			
Flip Chart w/ Pens	☐	☐			
White board w/ Scanner	☐	☐			